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# Shouting at each other into the void: A linguistic network analysis of vaccine hesitance and support in online discourse regarding California law SB277

Kali DeDominicis (PhD)[a,*], Alison M. Buttenheim (PhD, MBA)[b], Amanda C. Howa (MPH)[c], Paul L. Delamater (PhD)[d], Daniel Salmon (PhD, MPH)[e], Saad B. Omer (MBBS, MPH, PhD)[f], Nicola P. Klein (MD, PhD)[g]

[a] Arcadia University, Department of Sociology, Anthropology & Criminal Justice, USA
[b] Department of Family and Community Health, University of Pennsylvania School of Nursing, Center for Health Incentives and Behavioral Economics, Perelman School of Medicine, University of Pennsylvania, Claire M. Fagin Hall, 418 Curie Boulevard, Philadelphia, PA, 19104, USA
[c] Hubert Department of Public Health, Rollins School of Public Health, Emory University, 201 Dowman Drive, Atlanta, 30322, Georgia
[d] Department of Geography and Carolina Population Center, University of North Carolina at Chapel Hill, 123 Franklin St., Room 2152, Chapel Hill, NC, 27516, USA
[e] Department of International Health and Health Behavior and Society, Bloomberg School of Public Health, Johns Hopkins University, Institute for Vaccine Safety, Bloomberg School of Public Health, Johns Hopkins University, 615 N. Wolfe St., Room W5035, Baltimore, MA, 21205, USA
[f] Director of the Yale Institute for Global Health; Professor of Medicine (Infectious Diseases), Yale School of Medicine; Susan Dwight Bliss Professor of Epidemiology of Microbial Diseases, Yale School of Public Health; Adjunct Professor, Yale School of Nursing, USA
[g] Kaiser Permanente Vaccine Study Center, 2000 Broadway, Oakland, CA, 94612, USA

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ABSTRACT

In 2015, California passed Senate Bill 277 and became the third state in the United States to ban all nonmedical exemptions from school immunization requirements, effectively prohibiting religious and personal belief exemptions. This attracted grassroots opposition and considerable debate among vaccine hesitant factions online. This mixed-methods study used quantitative linguistic analysis, semantic network analysis, and content analysis techniques to examine 2424 online documents drawn from newspapers, blogs, health websites, government information pages, web forums, personal websites, Facebook groups, among others. The study examined which words and phrases were used most frequently by vaccine skeptics, vaccine defenders, and more neutral media accounts to illuminate how groups with different attitudes towards vaccination discuss and disseminate information about vaccines and vaccine policy online. We proposed an innovative methodology for examining online discourse surrounding vaccine hesitance, as well as for studying the online dissemination of misinformation about vaccines. Our findings highlighted discrepancies in the narratives between what vaccine supporters believe causes vaccine skepticism and the issues that vaccine skeptics actually discuss within their own digital spaces. For example, in these exchanges, the importance of parental rights overshadowed that of children's rights; supporters of vaccines brought up autism in more distinct documents than skeptics do; distrust of government regulators and researchers seemed to unite vaccine skeptics and defenders; and politicians, doctors, and even celebrities often served as proxies in heated exchanges about factual evidence, believability, and the importance of expertise in public discourse.

## 1. Introduction

In June 2015, the State of California passed Senate Bill 277 (SB277), which removed nonmedical exemptions for immunizations required for children entering public and private schools and child daycare centers (CLI, 2015). SB277 was created in response a measles outbreak at two Disney theme parks, which spread to seven states and Mexico. This was the worst measles outbreak California had seen in 15 years and, as with most recent measles outbreaks in the United States, it resulted from low vaccine coverage pockets due to vaccine refusal (Majumder et al., 2015). Many communities in California had measles, mumps, rubella (MMR) vaccine coverage rates below 60% (Bloch et al., 2015), as opposed to the recommended 92–95% (OECD, 2020).

SB277 was strongly opposed by a pre-existing movement of vaccine

* Corresponding author.
*E-mail addresses:* kali.dedominicis@gmail.com (K. DeDominicis), abut@nursing.upenn.edu (A.M. Buttenheim), amandahowa16@gmail.com (A.C. Howa), pld@email.unc.edu (P.L. Delamater), dsalmon1@jhu.edu (D. Salmon), saad.omer@yale.edu (S.B. Omer), nicola.klein@kp.org (N.P. Klein).

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skeptics, sometimes known as the "anti-vaxx" or "anti-vaccination" movement, which attributes a range of health problems to vaccines. The movement particularly associates vaccines with autism, which they often link to the use of mercury or thimerosal as a preservative (Kata, 2012). Although vaccine skeptics comprise a minority of the population, they are highly vocal, so they can influence parents who may be hesitant about vaccine safety (Kennedy et al., 2011). The movement often focuses on "vaccine choice" and emphasizes parental autonomy over public health protection from vaccines (Callender, 2016). Other opponents of SB277 support vaccinations but are politically opposed to vaccine mandates. This paper examined differences in how vaccine supporters and skeptics discuss vaccines and relevant policy, in order to help doctors and policymakers understand their patients' and constituents' perspectives and the variety of information they can access.

## 2. Study context

The Internet plays an increasingly important role in vaccine-skeptical activism and information dissemination (Getman et al., 2017). Parents who delay or decline vaccines are more likely to use the Internet as an information source than other parents, and it is unclear whether online discourse precipitated their beliefs or supported extant skepticism (Jones, Omer, Bednarczyk, Halsey, Moulton and Salmon, 2017; Salmon et al., 2009). The impact of the Internet on vaccine skepticism and the associated movement is harder to track than the influence of traditional media due to the increased difficulty of comprehensively cataloguing the vast array of digital spaces dedicated to the subject.

This study investigated online conversations surrounding SB277, including newspaper articles and other information sources (e.g. alternative health websites, conspiracy news sites, parenting forums). We examined how SB277 and the legislative process were represented online, and tried to reflect the experiences of and information available to parents trying to understand SB277. This research is distinct from other analyses of online vaccine sentiment because it engaged with a discrete policy effort and attitudes towards multiple vaccines, rather than one specific vaccine, and draws data from a range of sources, rather than focusing on a single platform (Madden et al., 2012; Ruiz and Barnett, 2015; Kata, 2010; Guidry et al., 2015). Our study also added to that literature by examining online sources of vaccine information, focused on evaluating the top results of web searches for relevant keywords.

## 3. Methodology

We analyzed documents published between June 2014, six months before the Disneyland measles outbreak, and June 2017, the end of the first school year after SB277 was implemented. The data represent information that would have been available to parents at the time, and includes only naturally-occurring discourse surrounding SB277, rather than replies to researchers' inquiry. Only text data were analyzed; graphics and YouTube videos were excluded.

A more detailed account of the methodologies used in this study can be found in a paired article ([our *DiB* co-submission]). Our approach used a form of snowball sampling (Baltar and Brunet, 2012) modified to reflect the network and flow of links. Data collection began with Google searches for "SB277," "California SB277," "California vaccine bill," and "Senate Bill 277." This yielded 13 websites that belonged to organizations associated with SB277 or general vaccine activism (Appendix 1). From there, we followed relevant links on each page to new websites – and followed relevant links on *those* websites to additional websites – and so on. All webpages were "scraped" and uploaded onto NVivo (QIP, 2014).

The snowball sampling approach was intended to retroactively approximate aspects of parents' experiences researching SB277. That is, the dataset reflected a web of links constructed to include most webpages a parent could potentially arrive at by conducting Google searches about this topic and then following links from those pages. Effectively, the dataset reconstructed the digital social network of people, lobbyists, corporate entities, and government bodies seeking to catch parents' attention and persuade them of a particular vaccine narrative. Necessarily, then, it also represented the semantic networks and rhetorical tactics employed by these groups to articulate their narratives.

Each unique page was considered a "document." Once uploaded to NVivo, documents were manually coded into qualitative categories according to the following attitudes: "vaccine supportive," "vaccine skeptical," or "neutral." [Our *DiB* co-submission] details the coding process in full, but manual coding was preferred because, even excluding video and graphic data, the documents produced through snowball sampling were highly representative of the multimodal, heterogeneous nature of digital texts; as such, the data and analysis in this paper establish a manual baseline that can enable future machine-based coding and analysis techniques. The supportive and skeptical attitude categories were *a priori* components of the analysis, because this research always intended to compare the two perspectives, but the neutral category emerged in analysis. Supportive documents were defined as those that actively asserted the medical benefits of vaccines and the scientific basis thereof, or included documents supportive of SB277 as a policy. Skeptical documents proclaimed the dangers of vaccines or vaccine mandates. Neutral documents did not attempt to influence readers towards either position, and expressed no implicit or explicit opinion about the efficacy of the bill or vaccination itself.

Comment sections were left *in situ* to preserve context; when comments were embedded at the bottom of a page, the main text and comments were considered a single document. When comments were accessible through a link to a separate page, they were considered two documents. Both discrete and embedded comments were coded according to the attitude of the original text. For an in-depth discussion of this decision, see ([our *DiB* co-submission]). Most significantly, coding comment sections this way preserved the context in which concerned parents might encounter these views: reading vaccine skeptical narratives in a neutral digital space (e.g., attached to a newspaper article) carries a different weight than finding them attached to a vaccine skeptical blog. This meant that comments sometimes represented views that conflicted with their attitude coding; to account for this, we analyzed the data with and without comment sections, and only found consequential discrepancies in one case (see Cluster 4 discussion).

NVivo was used to identify the 500 most common terms in each attitude category separately and for the dataset as a whole. This included phrases of up to three words. The Nvivo "stemmed" function combined coding for words with the same root, while manually-determined related words were also coded together. Thus, the individual words in our data actually represent a semantic network of similar words; for example, the word "child" also represents "children," "kid," "childhood," etc. Filler words were eliminated, as were certain overly-generic words; for example, "vaccine," "bill" and "people" merely demonstrate that these were discussions of vaccine policy, supported or opposed by groups of people. After these eliminations, the top ten words and top ten phrases in each attitude category were selected for further analysis. Terms that appeared in the top twenty of at least two categories were also included.

For each significant term, in-depth content analysis was applied to the five documents with the highest concentrations of that word. This decision was primarily efficiency-based: texts with high concentrations of a word provided more examples of how that word was used, how it was framed, and helped develop a qualitative idea of the semantic and narrative networks that surrounded it. The deeper, qualitative readings were undertaken using a documentary and textual analysis framework, with particular attention paid to how each term was used in context, and what issues and events they were most relevant to.

This article focused on how words were used in context and what

this suggested about the broader narratives and priorities of each attitude group. Although our data included a wide variety of media types, and future research could benefit from examining the divergent impact of particular technological platforms and document formats, this stage of research focused on the discourse as a whole. This was a continuation of our sampling logic: all of these documents were embedded in the same network of links, all of them were available to concerned parents and citizens. As such, establishing a baseline for how particular words were used by each group facilitates later examination of whether these patterns were impacted by media platform or format – and what implications this might have on the perceived accuracy of their assertions.

The content analysis process indicated that a semantic network approach (SNA) would improve our analysis: simply comparing high frequency words to each other would be less fruitful than using SNA to identify "emergent clusters of potential meaning by analyzing relations between words" (Ruiz and Barnett, 2015). For example, "parents' rights" and "[Dr. Robert] Sears" were both prominent terms, but it was less useful to compare them than to contrast the former to "civil rights," "human rights," and "children's rights." Semantic networks were constructed by drawing additional terms from the original lists of 500 words; these selections were guided by the NVivo (QIP, 2014) "word tree" SNA function and the context provided by initial qualitative content analysis. Most words were still in the top 20–50 for each attitude category, and the words that did not meet that frequency criteria were chosen for being part of the same semantic network as the high frequency words. In effect, the relative unpopularity of words that were linguistically or conceptually similar to high frequency words were included when they illuminated interesting aspects of the narrative choices and social framings espoused by the authors. These networks were divided into "clusters" of semantic networks relevant to the initial set of high frequency words.

There were substantially more skeptical documents than other types, which impeded direct comparisons between the three categories. Thus, percentages were calculated. This was done in two ways: first, the number of documents each keyword appears in, in each attitude category, out of the total number of documents in that category (D%). This demonstrated how widespread or general concern with that topic was among people with that attitude. For some clusters, we also calculated the number of times a word appeared in total per attitude category, out of the total number of times the word was used in that category (R%). We calculated R% in all cases (see Appendix 2), but this paper only includes charts of R% for clusters where there was a disparity between how often a word appeared in total versus how many documents it appeared in. For example, in Cluster 3 the word "mercury" appears in 23.7% of neutral documents, which is within 3% of the other categories – but it is 0.18% of all words in the neutral category, which is 5 times more frequent than in skeptical or supportive sources.

## 4. Results

The final dataset comprised 2424 documents from 213 websites. It was composed of web pages, Facebook statuses and public groups, newspaper articles, blog posts, government reports, and forum discussions. There were 433 "vaccine supportive" documents (2,894,317 words), 1717 "vaccine skeptical" documents (8,055,558 words), and 274 "neutral" documents (1,602,322 words). The final list of 79 words was divided into 6 Clusters (the full dataset can be found in [our *DiB* co-submission]).

### 4.1. Clusters

The semantic network of Cluster 1 (Fig. 1) was built around the phrases "vaccine choice" and "health freedom," both of which were among the ten most frequent vaccine skeptical phrases, and "health choice," which appears in the top twenty of all three categories. Permutations of "Anti-vaxx" were among the top twenty words used in vaccine supportive documents. This cluster suggests how each group views the issues and each other, and how they frame the debate.

Cluster 2 (Figs. 2 and 3) is a semantic network concerned with issues participants consider to be at stake: rights lost, issues contested, and medical issues caused or prevented. Most terms here appear in the ten most frequent words or phrases of at least one attitude category. "Civil Rights," "Children's Rights" and "Religious Exemption" were included for relevance to "Parents' Rights." "Disneyland," also less frequent, was included as the site of the original measles outbreak and as a public space, like schools, where the very presence of non-vaccinated children was contested.

Cluster 3 (Figs. 4 and 5) was built around the words "Measles," "Autism," and "Disease," which appear in the top ten words of all three attitude categories, and "Mercury," which was common in neutral documents. The other, less frequent words provided comparison for the primary words: additional viruses, vaccine components, and alleged side effects.

In Cluster 4 (Fig. 6), the most prominent words were "CDC," "California," "Pharmaceutical Industry," "Government," and "America." The words "Legal," "Illegal," "Big Pharma," and terms associated with constitutionality were added for thematic relevance. "Big Government" contextualized both "Big Pharma" and "Government," while the FDA represented another, similar government organization to compare the CDC to. "Fraud" was included because NVivo's computer-based SNA function (QIP, 2014) revealed that it appeared within five words of most other terms in this Cluster.

Cluster 5 (Fig. 7) examines racial and religious issues historically associated with malfeasance in medical research. It was unusual because only the phrase "Nuremberg Code" appears in the top twenty phrases of any attitude category (though less frequently than single words). Its frequency in the list of vaccine-skeptical phrases stood out, given its seeming irrelevance to SB277. Cluster 5 was assembled from the concepts contextually associated with it through qualitative analysis of relevant documents.

Cluster 6 (Fig. 8) is concerned with prominent names that appear repeatedly in this debate. Establishing credibility and publicizing issues was a significant aspect of the vaccine skeptic movement and SB277 debates. Thus, this cluster includes the names of every politician and celebrity in the top 500 words of each category, and the top five names that appeared after "Doctor" in NVivo word trees.

## 5. Discussion

### 5.1. Cluster 1

Cluster 1 (Fig. 1) was concerned with how the debate is framed; it compared phrases used to present and contest narratives regarding SB277. Pro-vaccine writers were the only ones who discussed SB277 as a form of advocacy, albeit in a limited sense; only 3.3% of them used the phrase "vaccine advocacy." They also did not (0.5%) coopt the language of "vaccine rights" in the sense of children having a right to vaccination, rather than parents having a right to decide whether to vaccinate. Vaccine skeptics also did not discuss the bill as a form of vaccine promotion or advocacy, instead presenting it as a form of fascism or tyranny – or, more often, as an attack on their freedom to make choices about medical treatment. Neutral sources accepted the choice argument to some extent (4.4% of documents), and also reported on vaccine promoters' framing of the bill as a form of vaccine advocacy.

Finally, the words "anti-vaxx" and "anti-vaxxer" are often used prejudicially by vaccine supporters. It was important to determine whether those words had been adopted or reclaimed by vaccine skeptics, or whether they saw nothing prejudicial about them to begin with. The data here is striking: vaccine supportive sources use these terms almost 12 percentage points more often than skeptical sources.

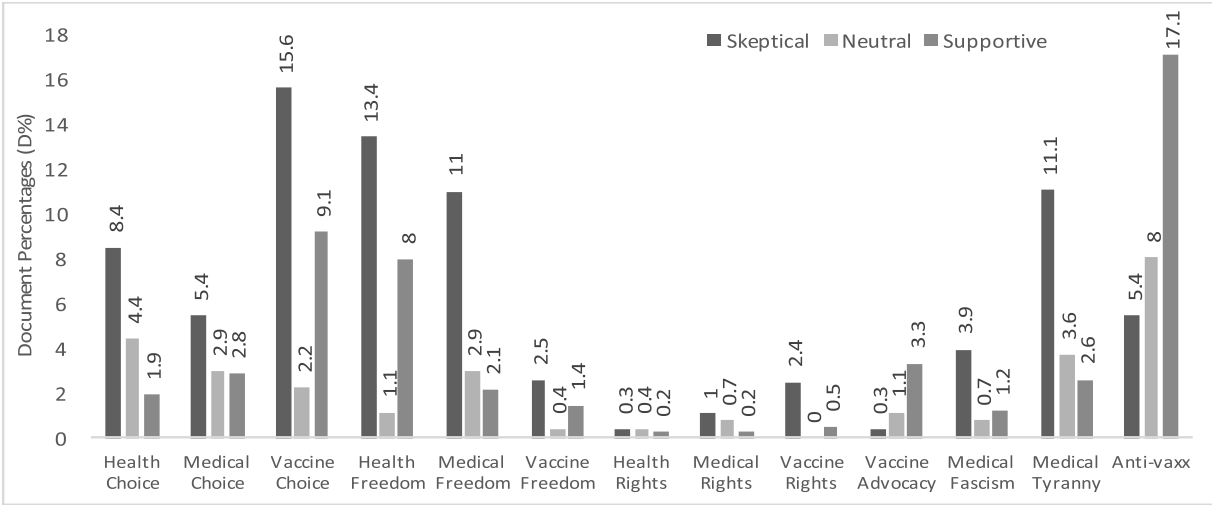


**Fig. 1.** D%, Cluster 1: The number of texts in an attitude category that each phrase appears in, relative to the total number of texts in that category.

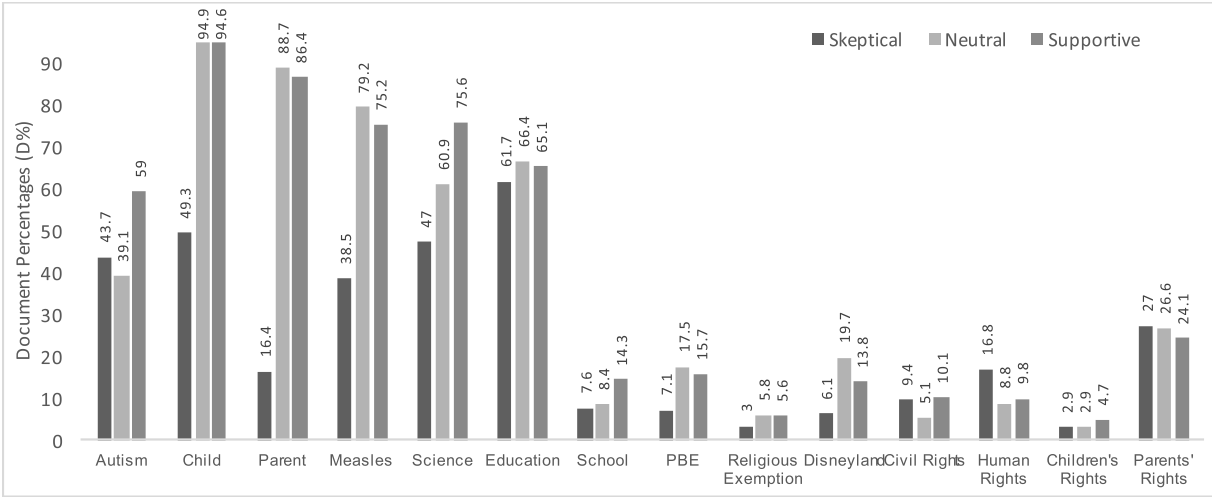


**Fig. 2.** D%, Cluster 2: The number of texts in an attitude category that each phrase appears in, relative to the total number of texts in that category.

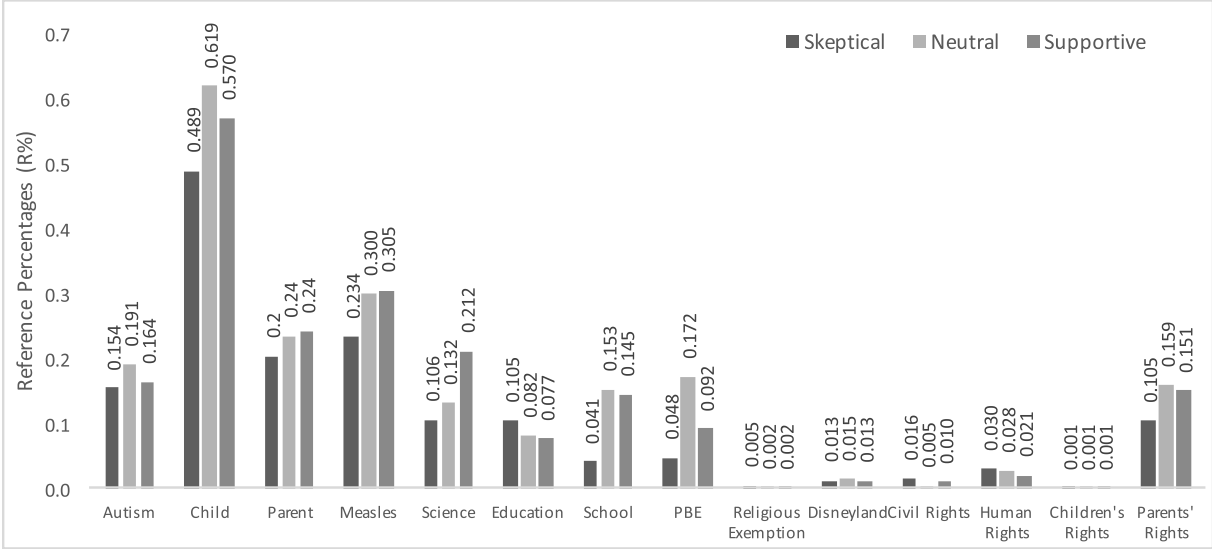


**Fig. 3.** R%, Cluster 2: The number of times a word appears in an attitude category, relative to the total number of words in that category.

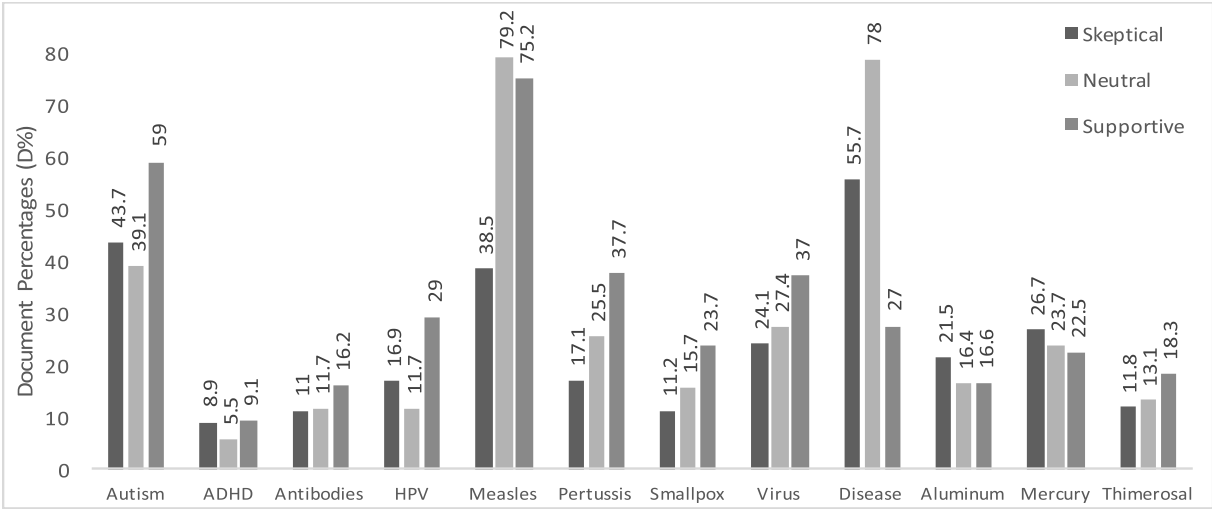


**Fig. 4.** D%, Cluster 3: The number of texts in an attitude category that each phrase appears in, relative to the total number of texts in that category.

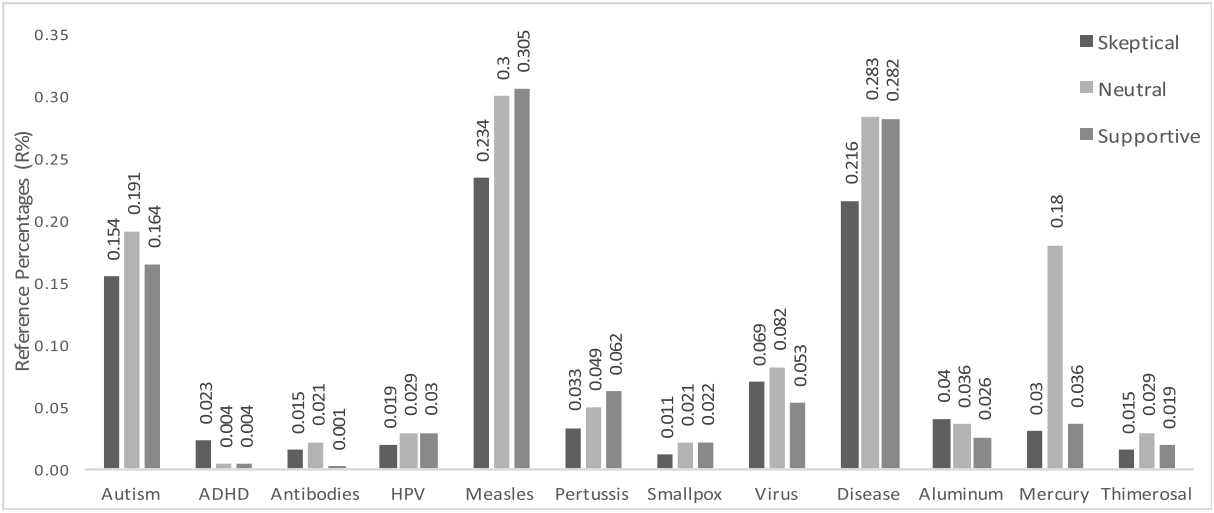


**Fig. 5.** R%, Cluster 3: The number of times a word is referenced in a given category, relative to the total number of words in that category.

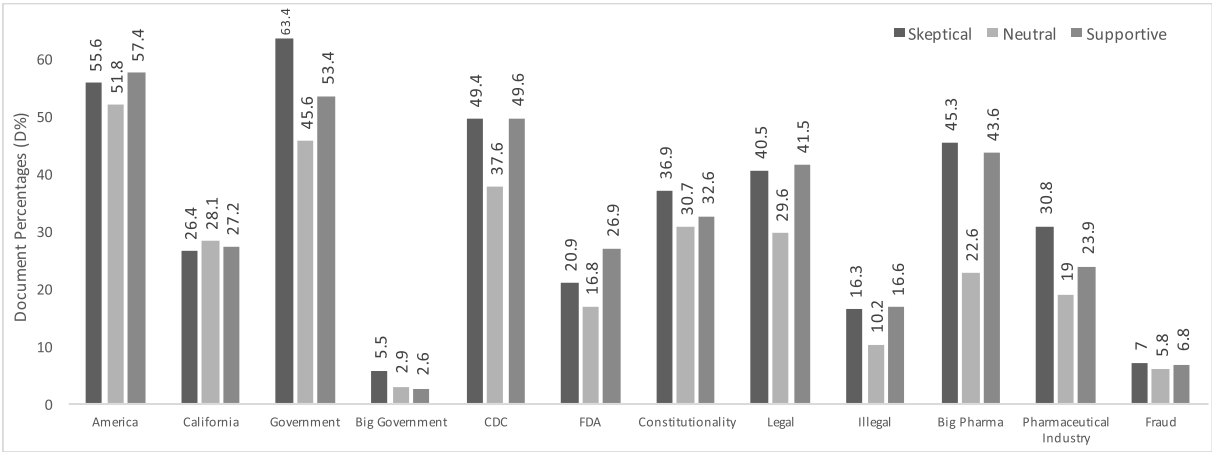


**Fig. 6.** D%, Cluster 4: The number of texts in an attitude category that each phrase appears in, relative to the total number of texts in that category.

Qualitative readings also revealed that it was common for vaccine skeptics to express disdain for the terminology, or to sarcastically discuss "anti-vaxxers" (Inanna, 2016). Thus, it seems prudent for those trying to change the views of vaccine skeptics to avoid these terms, whether online or in person.

### 5.2. Cluster 2

Cluster 2 represented the various issues participants felt were at stake in the passage of SB277 or the vaccine debate overall. Significantly, nearly 95% of journalistic and vaccine supportive texts

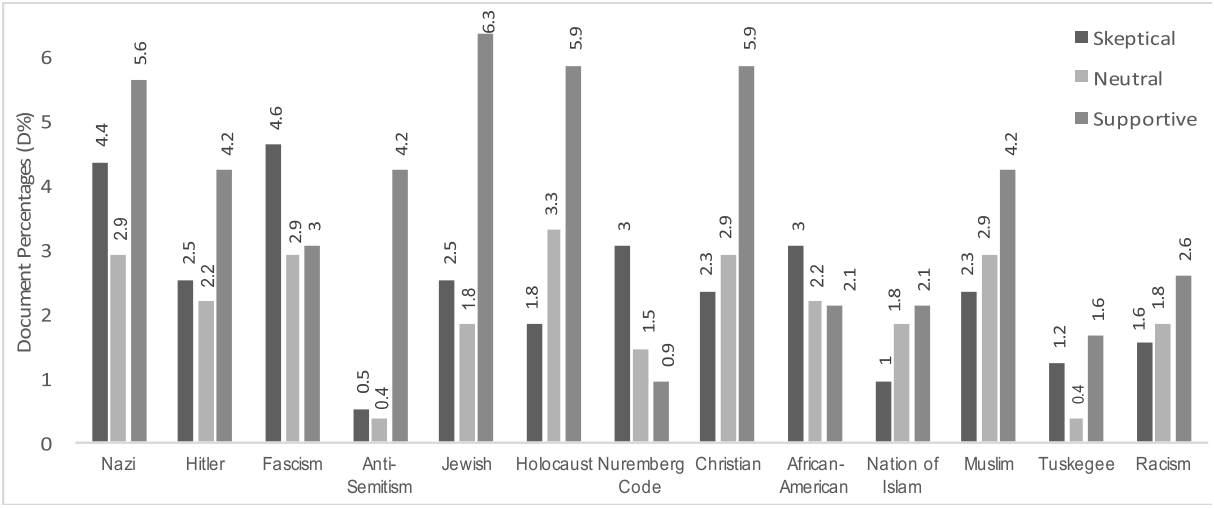


**Fig. 7.** D%, Cluster 5: The number of texts in an attitude category that each phrase appears in, relative to the total number of texts in that category.

considered children central to discussions of SB277. Only "parent" came close to reaching that coverage, which highlighted the fact that less than 50% of documents written by vaccine skeptics mentioned children at all. Although vaccine skeptics mention parent-related words in fewer documents, those words are used at higher frequency within the documents they do appear in. Additionally, 59% of vaccine-supportive documents mentioned autism at least once, which is 15.3% more often than vaccine-skeptical documents and 19.9% more than neutral ones (Fig. 2). Together, these data began to paint the vaccine skeptic movement, or at least the fight against SB277, as having complex motivations: skeptics associate it with more than *just* children, more than *just* fear of autism. Simultaneously, the figures suggested that vaccine proponents believe autism is the core of their opponents' position, and perhaps that convincing skeptics that vaccines do not cause autism will change their allegiance. This is consistent with findings that information-based approaches to correcting vaccine misinformation can backfire (Omer et al., 2017).

With regard to "measles" and "Disneyland," neutral and vaccine supportive documents were in agreement about the relevance of issues, while skeptics discussed them less. This illustrates an underlying theme in vaccine skeptic orthodoxy, which holds that measles are an ordinary, unimportant childhood experience (Papple, 2012; Sears, 2014). All groups agreed that this law was precipitated by the 2015 measles outbreak in Disneyland, but while the neutral and vaccine supportive groups emphasized the importance of this incident and the fact that it could happen again, vaccine skeptics framed SB277 as an overreaction to a minor issue.

Neutral and vaccine-supportive documents were also in alignment (within 0.2%) regarding the practical, civic, and legal issues represented by "Personal Belief Exemptions" (PBEs) and "Religious Exemption," the technical terms for the legal options eliminated by SB277. However, only 3% of vaccine-skeptical documents mentioned the elimination of religious exemptions, perhaps because the category was only differentiated from PBEs in 2012, with the passage of AB2109 (Brown, 2017). The relative lack of concern for religious rights highlighted the diverse demographics of vaccine skeptics, in California and elsewhere; unlike culture wars issues that organizations like Breitbart and Infowars usually involve themselves in, vaccine skeptical writers seemed less concerned with religious liberty than with acquiring a vaccine exemption by any means. Conversely, the frequency with which vaccine supporters invoked "science" suggests that they were fighting this battle on similar grounds to those on which they might debate abortion or LGBT + rights.

All three groups agreed on the significance of education. They even agreed on the framing of this issue: they were concerned that SB277 would negatively impact California children's right to a free and equal education. However, that agreement was belied by the aforementioned lack of emphasis vaccine skeptics placed on children. Of the rights

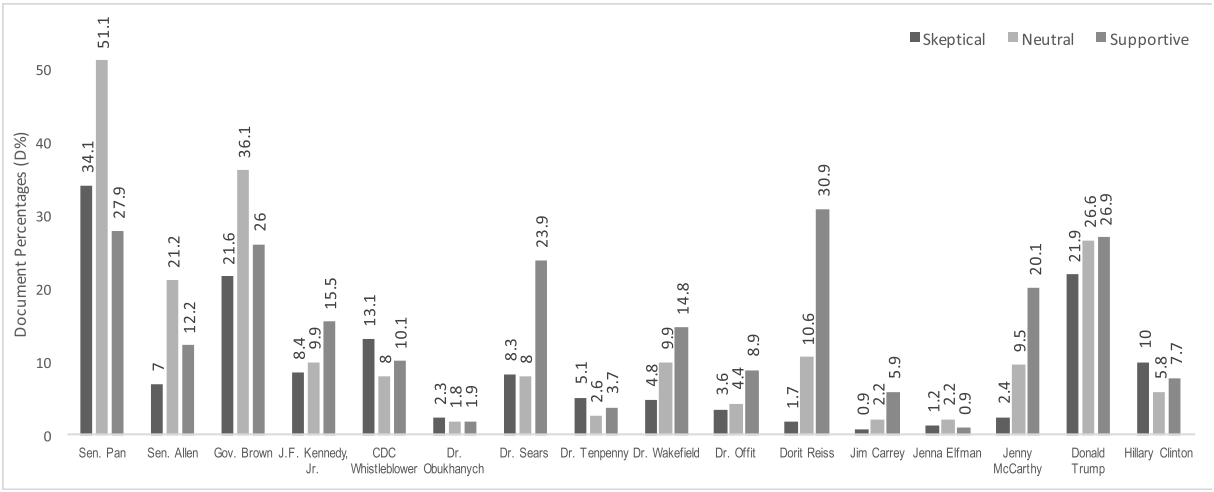


**Fig. 8.** D%, Cluster 6: The number of texts in an attitude category that each phrase appears in, relative to the total number of texts in that category.

mentioned in this data (human, civil, children's, and parents'), parental rights were most represented across all three groups. Even vaccine advocates, who asserted their commitment to protecting children's health, used more words reacting to skeptics' insistence that the law infringes on parents' rights to make medical choices and decide how their children should be raised.

Vaccine skeptics' more frequent use of "human rights" was noteworthy because the other groups discussed this as a civil rights issue: a matter of rights provided to citizens by their government and its laws. The "human rights" framing was traceable to Barbara Loe Fisher, president of the National Vaccine Information Center (NVIC), a prominent vaccine skeptical organization and lobbyist group. Fisher (2015) told an anti-SB277 rally, "We will not give up our human rights for our civil rights." These data suggest that Fisher's linguistic and political framing influenced how skeptics thought about SB277, which in turn has implications regarding the influence of the NVIC and individual personalities in the vaccine skeptic movement overall.

### 5.3. Cluster 3

Cluster 3 represented medical issues often associated with vaccines. This included alleged harmful ingredients in and side effects of vaccines, as well as viruses they combat. The most notable pattern was how consistently vaccine supportive document percentages are higher than the other groups. That held true whether vaccine proponents were arguing that autism and ADHD are proven not to be side effects of vaccines, invoking dangers associated with vaccine-preventable diseases such as measles or smallpox, or asserting the importance of vaccines in preventing viruses and creating antibodies. However, skeptical or neutral sources *mentioned* these issues more often, as shown by the percentage of times these words are referenced (Fig. 5), suggesting those key words were invoked repeatedly in debates. This emphasized the fact that for vaccine skeptics, this debate is about the dangers of SB277, not a referendum on their opinions about vaccine safety overall.

### 5.4. Cluster 4

Cluster 4 considered terms associated with America as a government and a symbol, and with conceptions of the rights and regulations afforded to citizens of democratic governments, like America. Thus, it addressed the legal and political dimensions of SB277, and the intersection of vaccine sentiments with government bodies that develop and regulate vaccines.

This cluster highlighted the connection between American democracy and the concept of freedom, which relates to the prominence of "health freedom" and "medical freedom" in Cluster 1. This was especially significant given that the word "America" (and variants like "United States," which were coded as one variable) appeared in over 51% of documents in every group. SB277 is a state law, not a federal one, yet references to "California" were lower in all three categories relative to mentions of "America" or "government." This suggested that all three groups understood SB277 as, on some level, a narrative struggle over America. The phrase "big government" often figures significantly in contested narratives of American government; political conservatives use it to represent their belief that the government is too large, wasteful, and interfering. Thus, the disfavor of that terminology in this context highlighted the mixed coalition of liberals and conservatives that comprise the vaccine skeptical and anti-SB277 movements.

Furthermore, while skeptical documents were especially likely to discuss the constitutionality of SB277 (36.9%), which could make it a subject for federal judicial arbitration, that inadequately explains why "America" (and similarly-coded words) appeared more often in all attitude categories than words like "constitutional" or "legal." This suggested that the *idea* of America is arguably more at issue here, in the imagined symbolic communities sense (Anderson, 1983/2006), which is tied directly to notions of freedom, choice, and rights that America represents. This also relates to the prominence of parental rights in Cluster 2: certain symbolic imaginings of America prize individual freedoms and people's right to make final decisions about the disposition of their family, because this separated America as an early democracy from nations struggling to divest themselves from feudal roots whereby overlords made decisions for their vassals (Zelinsky, 1988/2017). Biss (2014), in her philosophical history of inoculation, observed a similar connection between vaccines and nostalgic cultural obsessions with bodily independence and pre-modern concepts of physical purity. This supported the suggestion that attitudes towards vaccines are rooted in deeply held moral values, convictions and emotions, and that these underlying beliefs must be addressed before information-based persuasion can be effective (Amin et al., 2017).

The literal, practical realities of America as a country and a government were equally significant to the ideological dimensions. The CDC and FDA were regularly invoked by all attitude categories; especially the CDC, which is responsible for overseeing vaccine safety research on FDA-approved vaccines and for controlling outbreaks of disease, such as the 2015 Disney measles outbreak. The FDA approves vaccinations and other drug treatments as safe for public use. Vaccine adherents invoked those organizations to assert that they are safe and scientifically proven to prevent disease, and that the government vouches for their efficacy. Vaccine skeptics saw those organizations as scientifically dubious, beholden to government corruption and the pharmaceutical industry. It follows that "fraud" was a rare term that appeared at roughly equal levels across all groups, suggesting similar levels of concern. However, the framing by each group was predictably different: skeptics were concerned with demonstrating scientific fraud, within the CDC or among researchers more generally, while vaccine advocates primarily discussed and refuted this thesis. Neutral sources merely reported that a contingent of the anti-SB277 movement believed that certain vaccine research was fabricated, which may account for the slightly lower source percentage. Skeptics' concern with malfeasance in government agencies or scientific research, may account for the continued prominence of actors such as Dr. Andrew Wakefield, who provided the first fraudulent "proof" of a connection between vaccines and autism, or Dr. William Thompson, the "CDC Whistleblower" who alleged that the CDC suppressed evidence of that same connection (see Cluster 6).

The phrase "big pharma" is often used as a shorthand for expressing collusion between the pharmaceutical industry and the government or CDC. This corruption is a key aspect of how skeptics discredit vaccine research. Thus, it is interesting that all three groups used the phrase "Big Pharma" more often than "pharmaceutical industry" or "pharmaceutical company" combined. That gap was smallest for neutral sources; some uses of the more informal "big pharma" were accounted for in the comments, others in direct quotes in news reports. Thus, the relatively small gap could be explained by the fact that reporters overall seem to prefer the more neutral "pharmaceutical industry," while Internet commenters and citizen interviewees prefer the more casual and pejorative "big pharma." Amongst skeptical sources, the "big pharma" was preferred by 14.5%, while amongst pro-vaccination sources it was 19.7%. This suggested a certain limited affinity between the two opposed groups that was lacking elsewhere in the data: neither group trusted the pharmaceutical industry to prioritize science or health over profit. That affinity could potentially be fruitful for persuading vaccine hesitant parents, online and in person: acknowledge that everyone involved in this issue is skeptical of pharmaceutical companies, and emphasize assurances that counter their fears that "Big Pharma" will not protect them from fraudulent or harmful vaccines. Further, because government entities like the CDC or FDA are not considered trustworthy by many skeptics, it might be helpful to invoke individual doctors' medical expertise or independent research instead.

### 5.5. Cluster 5

Cluster 5 represented an especially contentious issue underlying vaccine debates: mistreatment of marginalized communities by governments and medical researchers. Half of the cluster was concerned with the Holocaust, the most dramatic example of this. However, three of those terms ("Nazi," "Hitler," "fascism") are also common epithets in online and political debates, usually used generically to insult people or assertions that are perceived as anti-freedom. Thus, those epithets also relate to aforementioned discussions of how vaccines fit into contested narratives about America and its status as a nation built on freedom. Vaccine-supportive documents used those terms more often (12.8%) than skeptical ones (11.5%), possibly because vaccine supporters had two concurrent agendas. First, they disputed the idea that SB277 makes America more fascist or Nazi-like, and second, they opposed drawing connections between a law designed to protect children using a humane and scientifically-proven medical practice and the worst genocide in history. Vaccine supporters' increased use of the words "Jewish," "Holocaust," and "anti-Semitic" make the latter agenda particularly explicit.

That pattern was repeated in references to "Nation of Islam," "Muslims," or "Tuskegee." The Nation of Islam is an African-American political and religious movement, one that the conservative or Christian portions of the vaccine skeptic coalition would not normally ally with. However, in June 2015, the Nation announced its opposition to SB277, and the vaccine skeptic movement responded with a brief spate of articles decrying SB277 as racist, and harmful to African-Americans and Muslims (e.g., McGreevy, 2015). These documents particularly invoked the infamous Tuskegee Experiment, in which the U.S. government observed the progression of syphilis in impoverished African-American men without informing them that they were not being treated or obtaining their consent to participate in such an experiment (Reverby, 2009). However, that interest among anti-SB277 activists was short-lived, as is attested by the relatively small percentages associated with those terms (Fig. 7), while vaccine-supportive sources' outrage was more prolonged. The CDC Whistleblower mentioned in Cluster 4 was also relevant here because the malpractice Dr. William Thompson allegedly exposed was portrayed as "evidence" that the CDC suppressed a study that proved vaccine exposure was linked to autism specifically among African-American males (Hooker, 2016).

The semantic network of racism-adjacent terms probably explains the unusual prominence of the phrase "African-American" in vaccine-skeptical documents: while this coalition did not sustain interest in any single issue, their overall concern with the relationship between African-Americans and vaccines was more consistent, though it is impossible to tell how many of the entities expressing concern were part of that community (see Boellstorff, 2008).

The Nuremberg Code was the only other phrase in this cluster used more frequently by vaccine skeptics. While technically an outgrowth of the Holocaust discourse, the prominence of this phrase appeared to be the result of a deliberate strategy by NVIC, the vaccine-skeptical lobbyist group, as an outgrowth of their "human rights" narrative discussed in Cluster 2. Skeptical sources usually argued that SB277 was a violation of the Nuremberg Code because it denies their American right to freedom and self-determination and their *human* right to make informed medical decisions for themselves.

Content analysis demonstrated that mentions of Christianity fell into two primary patterns. First, vaccine supporters and skeptics both invoked their Christianity to add moral authority to their arguments. This contrasted with discussions of Islam, which were primarily invoked by non-Muslim vaccine skeptics to indicate their concern for the racial issues discussed above. Second, Christian vaccine supporters often attempted to use their religious affiliation to make common ground with vaccine skeptics. Given that vaccine-skeptical documents used the word "Christianity" at half the rate of vaccine-supportive documents, this might be another example of the pattern whereby vaccine advocates believe the vaccine skeptical coalition prioritizes certain things, such as autism prevention, and becomes entrenched in a debate based on mistaken foundations. However, the current data could not definitively confirm this theory.

### 5.6. Cluster 6

Cluster 6 represented an effort to grapple with the impact of expertise and celebrity on the passage of SB277. Senator Richard Pan was the most prominent of these figures, despite the fact that he was only a *co*-sponsor of the bill; Senator Ben Allen, the other sponsor, only ranked fifth in combined source percentages (Fig. 8). This might have been because Senator Pan is also a pediatrician and known vaccine advocate, and because his political profile included sponsoring many similar bills. Sen. Allen was also less prominent than Governor Jerry Brown, probably because anti-SB277 activists hoped that they could dissuade the Governor from signing the bill until the last moment (e.g., Richardson, 2015). Robert Kennedy Jr., a lawyer and outspoken opponent of vaccines who was allegedly considered to lead a commission on vaccine safety (Phillip, Sun and Bernstein, 2015), and was thus one of the more prominent vaccine-skeptical political operatives, only ranked seventh.

That was particularly noteworthy because Cluster 6 was primarily characterized by attacks. Vaccine skeptics were angry that Senator Pan was encroaching on their rights, vaccine advocates were upset that someone like Kennedy could be considered for federal leadership. The fact that there were more angry skeptics than angry vaccine advocates suggested that while supporters were incensed by their opponents' behaviors, they were more willing to trust that the government and legislative process would take what they perceived as the appropriate action. Instead, vaccine supportive documents saved their attacks for vaccine-skeptical doctors. They mention Dr. Bob Sears, the most prominent Californian doctor to protest SB277, 15.6 percentage points more often than vaccine-hesitant documents. Furthermore, they achieved that lead despite a coordinated social media campaign by anti-SB277 activists to support Dr. Sears.

Both sides heavily invested in using prominent figures to advance the legitimacy of their cause. Vaccine advocates used Dr. Paul Offit, Director of the Vaccine Education Center at the Children's Hospital of Philadelphia, as their medical expert, and Dorit Reiss, a Professor of Law at University of California – Hastings, as their legal expert. (However, some of Professor Reiss's prominence in this dataset was due to the fact that she herself wrote comments and blog posts that appeared in the dataset, usually in neutral or vaccine supportive spaces). Vaccine skeptics are aware that their beliefs are considered medically suspect, which perhaps accounted for the greater number of vaccine-skeptical MDs who were referenced enough to be represented on this list. These included the aforementioned Dr. Sears; Dr. Sheri Tenpenny, an established vaccine skeptic who runs a popular vaccine skeptical Facebook group; Dr. Andrew Wakefield, whose 1998 study galvanized the modern vaccine denial movement (Callender, 2016); and Dr. Tetyana Obukhanych, an immunologist with Harvard and Stanford credentials, who is no longer involved in medical research (SkepticalRaptor, 2017). Few of these doctors continue to practice medicine; some because they now make their living as professional vaccine skeptics, others because they have left the medical establishment.

That perceived illegitimacy may also have accounted for the prominence of celebrities in this data: Jenny McCarthy, Jim Carrey, and Jenna Elfman. Although, these celebrities were not presented as medical experts, they utilized their media platforms to speak out and influence their listeners. However, within this dataset, McCarthy and Carrey were both invoked more often by *pro*-vaccine sources, usually to condemn the use of their fame to promote vaccine hesitancy, or to deride vaccine skeptics who perceived them as legitimate authorities. Elfman is less famous, which perhaps made her too insignificant a target. Regardless of the intention of celebrity endorsements, they did

not seem to have a net positive effect on the vaccination skeptical or anti-SB277 movements.

Donald Trump and Hillary Clinton were the final prominent figures in the data, in part because much of the SB277 debate occurred during the 2016 presidential election cycle. As with much of Cluster 6, the majority of these references seem to be attacks: Clinton, a vaccine supporter (Lopez, 2016), is mentioned 2.3 percentage points more often in vaccine skeptical sources, while vaccine-skeptical Trump (Khazan, 2017) is referenced 5 percentage points more often in vaccine supportive sources. However, that belies the fact that Trump was the third most-referenced individual in this cluster, appearing in 21.9% of skeptical sources. As such, he adds further evidence to the theory that the vaccine skeptic movement is invested in prominent, powerful sources – be they celebrities or politicians – who can balance the somewhat suspect medical credentials of their experts.

### 5.7. Limitations

These data were collected in relation to California law SB277, so they are not necessarily reflective of general online debates about the safety of vaccines or the efficacy of particular vaccine policy, or the general attitudes and debate techniques of vaccine skeptics or advocates. However, they do provide a starting point for studying online aspects of the vaccine skeptic movement, in terms of both data and methodology. It was also significant that this study was limited to textual data: YouTube videos, images (particularly memes), and Twitter texts were an important aspect of the exchanges studied, but they were sufficiently different in content and style from the texts examined in this paper that they were relegated to future studies.

In addition, while Californians are somewhat representative of demographics relevant to vaccine hesitance across the United States, they differ in certain key ways. The Hispanic or Latino population of California is more than twice that of the national rate, as is the percentage of the population who speak a language other than English at home (U.S. Census Bureau, 2019). Furthermore, while the college education rate is relatively similar, the California high school graduation rate is over 5% lower than the national rate (Ibid.). These demographics have implications for immigration status, confidence in doctors as well as government agencies and services, and general medical literacy. Racial minorities also have a history of being targeted by the vaccine skeptic movement; for example, the recent measles outbreak among the Somali population in Minneapolis was exacerbated by vaccine-skeptical advocacy (Dyer, 2017).

Finally, it is relatively impossible in archival Internet research to identify or verify individual actors. That means it is theoretically possible that the vast majority of this data was produced by a small group of actors, possibly posing as multiple individuals. However, the intention of this study was to approximate the experience of parents seeking information about SB277. Thus, because parents would have found it impossible to distinguish such bad actors, it is arguably irrelevant that researchers were also unable to do so (Boellstorff, 2008).

## 6. Conclusions

The online activities of the vaccine skeptic movement, as well as general online discussion of vaccines and dissemination of (mis)information, is a relatively understudied aspect of vaccine research. This analysis considered discussions of a single policy attempt to address inadequate vaccine coverage. Examining concrete responses to a specific policy, rather than the general fears and skepticism that surround vaccines, enables this research to contribute in two ways. First, it sheds light on general online vaccine debate and provides a model for how further research into the broader vaccine skeptic movement might proceed. Second, it can contribute to policy solutions by providing lawmakers with information about the specific concerns, issues, and points of friction associated with vaccine mandates. This research particularly illuminates the complexity of the vaccine skeptic coalition. Vaccine proponents often presume certain motivations on the part of their opponents – in particular, the belief that vaccines cause autism – but this data shows that vaccine skeptics have a wide variety of concerns. Thus, as Omer et al. (2017) noted in other contexts, information-based arguments intended to address specific false narratives, particularly regarding autism, can backfire.

Methodologically, this paper proposes a framework for future digital research that takes an organic, social approach to data collection. Our modified form of snowball sampling approximates the web of links, social recommendations, and interpersonal or technological connections that often inform ordinary individuals' efforts at online knowledge acquisition. The heterogeneous dataset yielded by this technique could certainly benefit from additional study: the current analysis excludes graphic and video data and relies heavily on manual coding and analysis techniques. Future research could benefit from subjecting this data to machine-based analysis; in particular, it would be interesting to see how much these results differed from interpretations based on sentiment analysis that categorized particular texts or passages as extreme or moderate.

California is a useful case study for examining online responses to policy mandates because it is relatively representative of relevant demographics across the U.S.: college education in California is only 1.6% below the national average, median household income is about $10,000 above average, and computer ownership is 2% above average (U.S. Census Bureau, 2019). These factors affect individuals' ability to access vaccine information online, and may impact how they intellectually engage with or internalize those arguments. In addition, California is the most populous state in the United States, with an economy larger than most countries, so its policies can have a disproportionate effect on the rest of America (Kettman, 2018). California also went from a relatively permissive policy attitude towards exemptions to a strict one in a short period of time, as demonstrated by SB277 and also AB2109, which was an earlier bill that required parents to discuss vaccines with a physician before obtaining an exemption. Thus, this analysis begins to illuminate how Americans might respond to vaccine mandates or other rapid shifts in policy. This is important because other states are increasingly contemplating enacting similar policies, and the ability to predict responses by the population may be useful for doctors and legislators.

The most significant trend in these data was the fact that vaccine skeptics, regardless of their opinions on the medical implications of vaccines, preferred to argue about vaccine policy on ideological or legal grounds. They used words like "freedom" and "choice," and protested the loss of their "human rights," or "parental rights" to make decisions about their children's health. Likewise, they brought up historical human rights abuses to defend their opposition to the law and to government interference on parental vaccine choices. They talked in macro terms about "America," "government," "constitutionality," "legality," and specific federal agencies considerably more than they talked about this as a law specific to "California," or its impact on "children." They also mentioned America and constitutionality more than the alleged medical consequences of vaccines that ostensibly fuel their resistance to vaccines. In addition, their words reflected a tendency to attack Senator Pan and then-candidate Clinton, appeal to Governor Brown, and campaign for vaccine-skeptical then-candidate Trump more often than they invoked either medical or celebrity endorsements for their positions.

Conversely, vaccine advocates online did not appear to view this as a political debate. They accordingly did not shift away from medical arguments and towards political or ideological ones. While they did frame vaccine mandates as an issue of "civil rights" (as opposed to vaccine-skeptical framing of "human rights"), advocates were more likely to mention the harm that vaccine hesitancy may cause to children, and to dispute the scientific arguments for vaccine skepticism, from "autism" to "thimerosal." Vaccine supporters also expressed outrage about skeptics mentioning the Holocaust or Tuskegee, which they

viewed as irrelevant or decontextualized invocations of marginalized groups' trauma to justify vaccine skepticism. Vaccine supporters were also vocal in their scorn for medical experts who espoused what they viewed as dangerously incorrect science.

Vaccine skeptics and supporters exhibited similar levels of concern with government fraud, and the notion that federal agencies and medical testing protocols may not have citizens' best interests at heart. Both were also concerned about the impact that vaccine mandates may have on children's educational outcomes. However, while both groups agreed that vaccine skeptics are opposed to some or all vaccines for a variety of reasons, vaccine advocates were more likely to use the disparaging term "anti-vaxxers" – and as such, advocates might find it more effective to avoid that term.

## Credit author statement

Kali DeDominicis: Conceptualization; Data curation, Formal analysis, Investigation, Methodology, Resources, Visualization, Roles/Writing – original draft, Writing - review & editing. Alison M. Buttenheim Writing – Review & Editing, Validation. Amanda C. Howa: Project administration, Validation, Writing - review & editing. Paul L. Delamater: Writing - review & editing. Daniel Salmon: Writing - review & editing. Nicola P. Klein: Writing - review & editing. Saad B. Omer: Writing - review & editing, Funding acquisition.

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## Appendix A. Supplementary data

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