This study examines the ways in which the public discusses and debates the scientific issue of vaccinations in the online social media environment of Facebook. We apply a mixed-methods approach, where a qualitative analysis is combined with a quantitative analysis of the characteristics of the debate on polio vaccinations in a Facebook group dedicated to parental and professional dialogue. The qualitative analysis suggested that dialogue became more political than scientific overall, yet the quantitative analysis showed that the discussants did not abandon the scientific nature of the issue at hand.

**INTRODUCTION**

On May 28, 2013, traces of wild polio virus were found in the sewage system near the settlement of Rahat in the southern part of Israel. In mid-August 2013, Israel’s Ministry of Health, with the massive encouragement of the World Health Organization (WHO), launched a full-scale vaccination campaign called “two drops.” The Ministry of Health reinstated a vaccine that had been taken off the national vaccination list eight years earlier. This unconventional call by the Ministry of Health for all parents to have their children vaccinated outside of the routine set of vaccinations prompted a wide-ranging public debate (1, 2). It involved public representatives, as well as officials from the Ministry of Health, and attracted tremendous media attention (3). The most active and diverse public-debate platform at that time was a Facebook discussion group called Parents Talk About Polio Vaccination, or Horim Medabrim al Hisun HaPolio in Hebrew (https://www.facebook.com/groups/154989868031889/) (4). We chose to base our research on this group. At its peak, the group had 1,741 members (November 12, 2013), and a posting rate of 109 posts per day (August 21, 2013). The group is no longer active.

**BACKGROUND**

Vaccine hesitancy and public engagement with science

Although health authorities regard routine childhood vaccines as safe and effective, and although vaccination coverage rates are high in high-income countries, many parents in these countries still hesitate to give them (13% worldwide, 17% in WHO European region) (5). Vaccine hesitancy is a decision-making process that depends (among other variables) on trust in the health authorities and in mainstream medicine (6, 7). The vast majority of the public are not biologists or epidemiologists, and they are not familiar with the scientific apparatus of vaccinations. They thus need to trust the sources that deliver the information to them and act upon guidance from these sources (8, 9). In such situations, people are more concerned with evaluating and validating the source of the information (i.e., the expert or the authority) than they are assessing the veracity of a claim based on their own understanding (10, 11). This opens the door to political considerations and evaluations of the sources who deliver the information. We consider “political” anything that involves power relations, including dialogue and public engagement in the scientific realm (12). The mainstream media and social media are among the most important and powerful agents that mediate between science and the public (13, 14), and hence we relate to the concept of “media logic.” Media logic is a term coined by David Altheide and Robert Snow (1979), who first used it in their book of the same name to depict the ways in which the media culture affects how people see and interpret social affairs. The term has been widely used since then (15–17), including in the field of science communication, where it usually refers to the ways in which scientists alter descriptions.
and explanations of their findings to better fit the way the media works (18). The media researcher Lance Bennett (19) discusses four main biases that affect almost every media product: personalization (the focus on the personal rather than the general and public), dramatization (the focus on spectacle and sensationalism), fragmentation (bits of information detached from context), and the authority-disorder bias (focusing on the restoration of authority in society).

The polio vaccination debates on Facebook are a clear example of public engagement with a scientific issue, and illustrate the ways people deploy scientific knowledge alongside other resources in the case of vaccine hesitancy (20, 21). When public engagement with science is discussed in the literature, it is described as a space for exchange of values and ideas (22); this certainly applies to the social media environment. The role of dialogue in such a space is often to build and promote trust between decision-makers and/or scientific experts and the lay public (23, 24). Facts alone are often not enough to activate and influence attitudes and behavior (25).

Online and social media discussions on vaccinations have been previously examined in various forms and cases. For example, a 2015 study of Italian online forums on childhood vaccinations found that there is a lot of misleading and false information online (26). This study has also found that both vaccination supporters and opponents use and cite medical professionals as their information sources. Another study, from 2012, of a Spanish website on vaccinations which offers a personalized service called “ask the expert” (27), analyzed the characteristics of the questions asked. This study found that 30% of the questions were related to vaccine safety and were associated with risk factors and age. Nevertheless, it is still largely unknown how online environments affect the communication between scientific experts and nonexperts, and subsequent decision-making among the public (28–30).

Our objective in this study was to characterize public engagement with the 2013 polio crisis in Israel in a social media environment. We followed two research questions.

RQ1: To what extent are components of scientific thinking observed in these discussions?

RQ2: What major themes appear in online discussions about the polio vaccine?

METHODS

Qualitative data collection

To collect the qualitative data, a manual search in the Facebook group Parents Talk About Polio Vaccination was conducted by the first author. This purposive sampling was carried out according to three main criteria: rich discussion (at least 25 comments per conversation); diverse participants (both lay and professional); and diverse views (both for and against the vaccination).

Forty conversations (threads) were collected. The texts are all in Hebrew and were originally analyzed in Hebrew, and then translated for this paper. All the raw data are available for scientific use from the authors.

Quantitative data collection and sampling

A data-mining technique was used to collect the group’s written data using the Hypertext Preprocessor (PHP) script available from the Facebook site. This script served to collect each post’s first 25 comments (the maximum number of comments that the script allowed us to collect). If the post had more comments, which was true for about 200 of the 1,039 posts comprising the sampling frame, these comments did not appear in our quantitative database. Overall, we collected all threads posted from August 14 to November 12, 2013, for a total of 11,535 items (where an “item” was defined as a post’s headline or a single comment, both of which were analyzed in the same way). On these, we performed a random subsampling using a “randomize numbers” command (=20%), and ended up with 2,289 items. We then performed a purposive subsampling on these items as follows.

We first excluded “polite” items (such as thanking everyone who helped and contributed information) and “administrative” items (such as asking where the nearest nurse’s office was). This left us with 1,793 items, written by 321 different commentators. Then, we excluded all items which did not express clear positions on the polio vaccination (for, against, or a complex position) and all items which did not include a clear narrative. The presence of a narrative suggests there was an interaction or an act of persuasion (31). Social narratives of vaccination have been shown to inform and impact the individual (32, 33). This left us with a final sample of 401 items.

Qualitative data analysis

A grounded theory approach guided our analysis (34, 35). The qualitative data were analyzed thematically (36, 37): the texts were tested for emerging themes, in a triple-stage refinement procedure. The refinement procedure is a process in which the categories that arise in the grounded theory analysis are narrowed and focused until the most representative and reflective themes are found. Each refinement stage consisted of a careful reading and examination of the texts, followed by a mapping and straining of the themes that emerged. By the end of each refinement stage, some of the themes were fused together into a broader theme. Each refinement stage left us with broader and more inclusive themes. By the end of the third refinement stage, we felt the themes could not be grouped or fused any further, and this is where we ended the analysis. We were left with three comprehensive themes, all of which reported in the results section.

Quantitative operationalization and data analysis

The quantitative data were analyzed using a quantitative content analysis approach (38). We coded the topics covered
in each item, the socio-demographics of the writers, and their use of evidence.

- The codes for topics were: administrative, expressions of politeness, scientific/medical, political-economic issues, personal concerns or dilemmas, societal issues and concerns, moral issues and concerns.
- The socio-demographic variables we coded were gender, age, education, occupation, and marital and family status.
- Because the use of scientific evidence is a classic indicator of the extent to which an item is scientific (39, 40), the codebook contained several coding options for what was considered evidence: the viewpoint of a researcher; a reference to a completed, published study; a reference to a research method; or a reference to a research result.

For examples of classification of items according to topic and use of evidence, see Appendix 1.

We also examined the scientific components present in each item. We drew on the operational definitions of nature of science (NOS) and scientific inquiry (SI) suggested by the American Next Generation Science Standards (NGSS, www.nextgenscience.org/next-generation-science-standards). The category nature of science included references to the following: the methods employed in science; scientific knowledge as based on empirical evidence; scientific knowledge as subject to change and criticism; the ways in which scientific models explain phenomena; science as a way to obtain knowledge; scientific knowledge as a means to achieve order; and the way science relates to the natural world. The category scientific inquiry included references to the following: how scientific questions are asked, models are developed, and research is planned; how scientists analyze data, use mathematics or statistics, construct their arguments, and use evidence; and the ways scientists communicate their findings.

Finally, positions toward polio vaccinations and vaccinations in general were coded for each item. For example, the following was coded as a pro-vaccination item: “If you leave yourself open to natural contamination, you are at much greater risk.”

Validation and statistical analysis

The codebook benefited from the feedback and expert content validation of two international science-communication scholars: Professor Bruce Lewenstein from Cornell University and Dr. Meghna Tallapragada from Clemson University. Following their recommendations, we modified the codes for primary topic (added two codes for societal and moral issues), and added a code for narrative.

The data were analyzed using Excel and IBM SPSS Statistics v. 17 software. The Cohen’s Kappa score for the agreement between the first author and a trained coder on 150 items was 0.81. Since most of the variables in the codebook were measured on a nominal scale, non-parametric statistical tests (chi-squared and correspondence analysis) were used to calculate the relationship between variables. All outputs and materials are available and will be provided upon request.

Ethical considerations

The study of the texts written and shared by this particular content-driven Facebook group provided a unique opportunity to analyze events and discussions while the topic was very much “alive.” This analysis may give rise to ethical concerns, given that the products of public health–related human behavior are scrutinized (41). Nevertheless, according to the codes of ethics and conduct of internet research (42), if an observation of public behavior takes place in public situations where subjects would expect to be observed by strangers (such as an open Facebook discussion), explicit individual consent is not required (43–45). An IRB approval from the Ethics Committee of the authors’ affiliate institute was obtained. We based our conclusions solely on data collected from open-group discussions and open profiles. The names of the discussants used in the results section are pseudonyms.

RESULTS

The qualitative analysis of the discourse and dialogue in the Facebook group Parents Talk About Polio Vaccination revealed three major themes: capitulation to media logic, fear of uncertainty, and a shift from the scientific to the political domain.

Capitulation to media logic

Our analysis showed that the discussants in Parents Talk About Polio Vaccination adhered to the culture and conventions of the ways in which various topics are portrayed in the media, or in other words, capitulated to the biases and logic which govern the media. We found the same biases suggested by Bennett (19) in the dialogues in the group.

Personalization. This information bias is about focusing on the individual and human perspective, such as personal tragedies or victories. We saw that discussants in the group devoted much of the dialogue to personal, unique stories. One example widely referred to by the discussants was the story of a young boy who was given a polio vaccine and became permanently paralyzed afterwards. Maura, a discussant, wrote:

My friends are all hysterical. No one wants to vaccinate her children because of the story about that kid who is now paralyzed.
Dramatization. This information bias is about focusing on the simpler aspects of conflict and drama rather than complex and elaborate explanations (such as scientific explanations). Most discussants were reluctant to devote their time to understanding the ways in which the immune system or vaccinations work. Instead, they presented dramatic stories and explanations about how the Israeli Ministry of Health was cynically forcing innocent parents to give “toxic” substances to their children. For example, Layla, a discussant, wrote:

Can someone please tell me why am I supposed to follow instructions that tell me to give my daughter venom just so that the Ministry of Health can earn money and enhance its reputation?

Fragmentation. This information bias is about isolating stories and bits of information from their context, while disregarding “the big picture,” namely, the social, institutional, or organizational context. The information then becomes fragmented, and the full setting becomes much harder to obtain. The story of the paralyzed child whose paralysis had nothing to do with his polio vaccination is an example of fragmentation. This story was used repeatedly as a reason why parents should refrain from vaccinating their children, while ignoring the larger context of the story itself, as well as the larger context of the reasons why the vaccination was recommended in the first place.

The authority-disorder bias. This information bias is about dealing extensively with questions of public (dis) order, and whether the authorities are capable of creating and maintaining social order. This bias is expressed as an exaggerated emphasis on emotional facets of finding who is guilty and when order will be restored. For example, Dmitry, a discussant, wrote:

Too many cases of paralysis ever since this vaccination was brought to the attention of the public. I wonder who is going to account for this? Who stands behind all this? They are the ones to blame.

Fear of uncertainty

Many of the discussants were concerned about the uncertain outcomes of the vaccination. Many demanded complete certainty as regards the safety of the vaccine and its ingredients, as well as reassurance about the possible side effects of the vaccination, especially over the long term. Many said that they were afraid of vaccinating their children because an insufficient number of clinical trials had been carried out, so there was not enough evidence that the vaccination was 100% safe. Many discussants demanded a “guarantee” that no side effects would affect their children. For example, Nina wrote:

No one knows what the consequences are going to be in a year, two, or even ten years from now.

Another example can be found in a comment by Theodore:

I need to be a million percent sure. It is scary because there is a chance of one in…. no matter how much. Once someone is the one, they don’t care about statistics. There is a danger [of side effects] and the parents are anxious and wondering what is right.

The shift of the debate to the political domain

Public knowledge about vaccinations is necessarily second-hand knowledge; in other words, knowledge that was not gathered from direct evidence. This knowledge can only be acquired if people trust the source who delivers the information. Carol, a physician, wrote the following comment in response to Hannah, who expressed panic and her inability to trust the professionalism of the Ministry of Health:

Hannah, no one is putting any poison in our children’s bodies. Nor is this an experiment at your expense. This is a scare tactic. This is a method to create a wave of panic and lack of trust by the opponents, and sadly, they are succeeding. It is definitely important to read and be engaged, but it is also important to realize that there are complex issues, which not everyone can easily understand, and we have no choice but to trust the professionals who bear the responsibility for the health of us all.

Thus, the nature of the debate in the group Parents Talk About Polio Vaccination shifted from scientific to political and ethical. Many ethical arguments against the Ministry of Health, and even the World Health Organization, were voiced. These organizations were accused of taking advantage of their authoritative status and the trust the public places in them. For example, Maureen wrote:

If there is a risk even the most minimal, we are putting our children at risk, even though there is no health advantage for them. That does not sound ethical to me.

Similarly, Paul wrote:

How can we trust the Ministry of Health ever again? The Ministry of Health failed in their ability to protect public health. We must independently examine the ingredients of the vaccine.

Chloe wrote:

Maybe we should dismiss all the people who work at the Ministry of Health, and hire people who have a conscience.

In addition, many arguments regarding lack of transparency were expressed. Many suggested that the mainstream
media were concealing the truth from the public and conspiring with the Ministry of Health and other stakeholders to promote their financial and political interests. For example, Caitlin wrote:

The media are cooperating with the medical institutions and the pharmaceutical companies, and together they are hiding the truth from the public. The answers to the real questions cannot be found in the traditional media.

Leon and Dotan are examples of two discussants who were very critical of the Ministry of Health. They implied that the recommendation to vaccinate children with Oral Polio vaccine was motivated by political and financial rather than scientific considerations. Dotan noted that:

It seems that the truth is not profitable enough.

Leon wrote:

I fully support science and scientific research. What I do not support is research driven by interests, and the data which they [the Ministry of Health] present are exactly that.

Quantitative results

Our quantitative results indicate that science played a substantial part in the dialogues in the group Parents Talk About Polio Vaccination. Of the frequent contributors, 22 were physicians, who answered questions and addressed concerns rather than initiated discussions. They were responsible for 15% (n = 59) of the items. Nevertheless, they rarely identified themselves as such. Only 3% of the items (13 items) contained an explicit reference to self-expertise (e.g., "I am a doctor").

A quarter of the discussants had more than 300 Facebook friends, and 70% were members of at least 10 other groups, which suggests that the majority of discussants were active Facebook users. The majority of the discussants (67%, n = 270) were female. Thirty-three percent (n = 131) of the discussants were male. The majority of the items (75%) expressed a pro-vaccination position, 8% were against the polio vaccination, and 17% took a complex position. Most of the items did not reveal a position towards vaccinations in general. Marital status could be deduced from 37% of the items, indicating that 97% of the items came from people who were married with children.

Discussion topics. Half of the items addressed scientific or medical content. Of the 401 items analyzed, 50.1% (201 items) had scientific or medical topics (such as the virus, its characteristics, the vaccination, contagion, etc.) as their primary content. The remainder addressed societal issues and concerns (49 items, 12.2%); personal concerns (28 items, 7%); and other issues, such as court symposia or international contexts (117 items, 29.1%).

Use of evidence and scientific components. Although half the items addressed scientific or medical topics, most items (386 items, 96%) did not present any evidence at all to support their authors’ arguments. Only a small percentage presented a viewpoint or a comment by a researcher, or related to the results of a study or the use of a research method (14 items, 3.5% of the sample).

Nevertheless, we were able to identify scientific components in about a quarter of the sample. Twenty-four percent of the items (n = 96) contained features related to the nature of science (NOS). Twenty-seven percent of the items (n = 110) contained features of scientific inquiry (SI). Those items that employed SI features were more likely to employ NOS features as well, with an overlap of 80% (in other words, 80% of the items that employed SI features also employed NOS features). Moreover, 22% of the items (n = 90) discussed the ways in which science is communicated. Twelve percent (n = 48) of the items expressed a favorable position towards science and/or scientists.

There was a significant association between stance on polio vaccination and the use of evidence (χ² = 49.03, p < 0.005). Commentators who supported polio vaccination tended to employ more empirical evidence than those who opposed it or had a complex position. The topic of discussion was marginally associated with the use of scientific components (χ² = 35.05, p < 0.06). The use of scientific components in the text was also related to the position on polio vaccination, with a value of χ² = 17.08 (p < 0.005) for the use of SI features, and a value of χ² = 28.03 (p < 0.005) for the use of NOS features. Commentators who supported polio vaccination were more likely to use scientific components.

Discussion

Our quantitative findings revealed that the discussion focused on science and medicine, and about a quarter of the items contained scientific components, even though empirical evidence was barely cited. This suggests that public engagement with science needs to be regarded in a more nuanced fashion (46). Our qualitative findings revealed that the discussion focused on fear of uncertain outcomes of vaccination, and on possible financial and political motivations for vaccination. This implies that expert sources are evaluated mostly as political agents, and points to the importance of considering not only the understanding of scientific aspects, but also the emotional and social context of vaccine hesitancy, as has been pointed out in various recent studies (32, 47–49). Focusing on science comprehension or use of empirical evidence may not be adequate to study and address vaccine hesitancy (50, 51). We hence need to regard the “science” component in public engagement with science as a broad and versatile constituent, which the public may interpret and deploy in many ways.

We found that most of the items in our sample were pro-vaccination. This may be due to the vast amount of information which was provided and exchanged in the group, as
information is known to reinforce the safety and importance of routine childhood vaccinations (52). Moreover, this finding is in line with the high eventual compliance rates with the vaccination (59.2% among the Jewish population and 92.4% among the Arab population) (53). Interestingly, studies on vaccine hesitancy suggest that the outcome of vaccine hesitancy is not necessarily non-compliance and can very often result in a decision to comply with vaccination (54, 55). The results of a recent Pew Research Center survey, which suggest that the vast majority of Americans believe that the benefits of childhood vaccines outweigh the risks (56), are in line with these studies.

The mixed-methods approach made it possible to look at both single items detached from their context (in the quantitative analysis) and items in the context of a full conversation in a thread (in the qualitative analysis). This complementary approach helped evaluate the dialogue in the group Parents Talk About Polio Vaccination in a “zoom out” and a “zoom in” fashion. In sum, qualitative analysis suggested that dialogue became more political than scientific overall, yet quantitative analysis showed that the discussants did not abandon the scientific nature of the issue at hand.

As noted in the introduction, public confidence in vaccines is waning (57). The polio vaccine is only one instance of vaccine hesitancy on social media (58). Other vaccine controversies, such as the controversy over the human papillomavirus (HPV) vaccine, have also been studied in online environments. Keelan et al. have studied discussions on the HPV vaccine on MySpace blogs, and found that men were more likely to hold negative views about the vaccine than women and to disseminate negative messages through larger social networks (59). They found, as we did, that the majority of views were pro-vaccination. Another recent study on vaccine-related Google searches has found that the interest for vaccines is increasing over time, and that the HPV vaccine was a popular Google search topic (60). Social media has recently emerged as an effective and strategic communication tool to address vaccine hesitancy and may become more important in coming years (61).

**Limitations and future work**

This study has two major limitations. First, in an informal conversation, people do not always supply empirical evidence for their claims (62). Therefore, the fact that many of the commentators did not supply empirical evidence does not necessarily mean they did not consider empirical evidence as required or useful, but could simply mean that they chose not to include it in their particular comment. The use in about a quarter of the comments of certain scientific components may actually support this claim. Second, only one Facebook group was studied, which limits our ability to draw wide-ranging conclusions from the findings. More comparative research is needed to extend generalizability.

Nevertheless, this case study of public engagement with science highlights the versatile and flexible nature of scientific dialogue in the public sphere. The main contribution of this study is in its illustration that science has much more malleable boundaries than is sometimes assumed.

**SUPPLEMENTAL MATERIALS**

Appendix I: Classification of items according to topic and use of evidence

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**REFERENCES**

1. Gesser-Edelsburg A, Shir-Raz Y, Green MS. 2014. Why do parents who usually vaccinate their children hesitate or refuse? General good vs. individual risk. J Risk Res 19(4):405–424.
2. Landsman K. 2014. Polio whack-a-mole. AEON, https://aeon.co/essays/how-anti-vaxxers-fuel-the-spread-of-polio.
3. Kaliner E, Moran-Gilad J, Grotto I, Somekh E, Kopel E, Gdlevich M, Shimron E, Amikam Y, Leventhal A, Lev B, Gamzu R. 2014. Silent reintroduction of wild-type poliovirus to Israel, 2013 – risk communication challenges in an argumentative atmosphere. Eurosurveillance 19:20703.
4. Orr D, Baram-Tsabari A, Landsman K. 2016. Social media as a platform for health-related public debates and discussions: the Polio vaccine on Facebook. Isr J Health Policy Res 5:34.
5. Larson HJ, de Figueiredo A, Xiahong Z, Schulz WS, Verger P, Johnston IG, Cook AR, Jones NS. 2016. The state of vaccine confidence 2016: global insights through a 67-country survey. EBioMedicine 12:295–301.
6. Black S. 2016. Recognizing the importance of vaccine confidence. EBioMedicine 12:28–29.
7. Larson HJ. 2014. Vaccine confidence and public trust as drivers of vaccine failure. Int J Infect Dis 21(Suppl 1):S0.
8. Kutrovátz G. 2010. Trust in experts: contextual patterns of warranted epistemic dependence. Balk J Philos 2:57–68.
9. John S. 2011. Expert testimony and epistemological free-riding: the MMR controversy. Philos Q 61:496–517.
10. Bromme R, Thomm E, Wolf V. 2015. From understanding to deference: laypersons’ and medical students’ views on conflicts within medicine. Int J Sci Educ Part B 5(1):68–91.
11. Scharrer L, Stadtler M, Bromme R. 2014. You’d better ask an expert: mitigating the comprehensibility effect on laypeople’s decisions about science-based knowledge claims. Appl Cogn Psychol 28:465–471.
12. Etzioni A. 2003. What is political? CSA Worldwide Political Science Abstracts, 2006, SSRN, https://ssrn.com/abstract=2157170.
13. Bucchi M. 1996. When scientists turn to the public: alternative routes in science communication. Public Underst Sci 5:375–394.
14. Scheufele DA. 2014. Science communication as political communication. Proc Natl Acad Sci USA 111(Suppl):13585–13592.

15. Alt heide DL. 2013. Media logic, social control, and fear. Commun Theory 23(3):223–238.

16. Deuze M. 2009. The media logic of media work. J Media Soc 1(1&2):22–40.

17. van Dijck J, Poell T. 2013. Understanding social media logic. Media Commun 1(1):2–14.

18. Plesner U. 2012. The performativity of “media logic” in the mass mediation of science. Public Underst Sci 21(6):674–688.

19. Bennett WL. 2005. News: the politics of illusion, 6th ed. Longman, New York.

20. Hine C. 2014. Head lice eradication as everyday engagement with science: an analysis of online parenting discussions. Public Underst Sci 23:574–591.

21. Mixter PF, Souza G. 2016. Role-playing in a vaccination debate strengthens student scientific debate skills for various audiences? J Microbiol Biol Educ 17:297–299.

22. Lewenstein BV. 2003. Models of public communication of science and technology. Public Underst Sci 96(3):288–293.

23. Merkelsen H. 2011. Risk communication and citizen engagement: what to expect from dialogue. J Risk Res 14:631–645.

24. Bhaduri S, Sharma A. 2012. Public understanding of participation in regulatory decision-making: the case of bottled water quality standards in India. Public Underst Sci 23(4):472–488.

25. Kahan DM. 2013. A risky science communication environment for vaccines. Science 342(6154):53–54.

26. Fadda M, Allam A, Schulz PJ. 2015. Arguments and sources on Italian online forums on childhood vaccinations: results of a content analysis. Vaccine 33(51):7152–7159.

27. García-Basteiro AL, Álvarez-Pasquín MJ, Mena G, Llupià A, Alder A, Sequera VG, Sanz S, Tuells J, Navarro-Alonso JA, de Arístegui J, Bayas JM. 2012. A public-professional web-bridge for vaccines and vaccination: user concerns about vaccine safety. Vaccine 30(25):3798–3805.

28. Mcfarland LA, Ployhart RE. 2015. Social media: a contextual framework to guide research and practice. J Appl Psychol 100:1653–1677.

29. Hendriks F, Kienhues D, Bromme R. 2016. Trust in science and the science of trust, p 143–159. In Blobaum B, Trust and the science of trust, p 143–159. In [Book Title], p 143–159. In [Publisher].

30. Vinot R. 2015. Ethics in information technology. BoingBoing, https://boingboing.net/2015/06/13/on-ethics-in-information-techn.html.

31. Flicker S, Haans D, Skinner H. 2004. Ethical dilemmas in research on Internet communities. Qual Health Res 14:124–134.

32. Carrion ML. 2017. “You need to do your research”: vaccines, contestable science, and maternal epistemology. Public Underst Sci 96366251772802.

33. Betsch C, Renkewitz F, Haase N. 2013. Effect of narrative reports about vaccine adverse events and bias-awareness disclaimers on vaccine decisions: a simulation of an online patient social network. Med Decis Making 33:14–25.

34. Holton JA. 2008. Grounded theory as a general research methodology. Grounded Theory Rev 7(2), http://groundedtheoryreview.com/2008/06/30/grounded-theory-as-a-general-research-methodology/.

35. Oktay JS. 2012. Introduction to grounded theory and its potential for social work. Grounded Theory doi:10.1093/acprof:oso/9780199753697.003.0001.

36. Condit CM, Gronnvoll M, Landau J, Shen L, Wright L, Harris TM. 2009. Believing in both genetic determinism and behavioral action: a materialist framework and implications. Public Underst Sci 18:730–746.

37. Douglas H. 2015. Politics and science: untangling values, ideologies, and reasons. Ann Am Acad Pol Soc Sci 658:296–306.

38. Flicker S, Haans D, Skinner H. 2004. Ethical dilemmas in research on Internet communities. Qual Health Res 14:124–134.

39. Goldman AI. 2001. Experts: which ones should you trust? Philos Phenomenol Res 63:85–110.

40. Guttmn M, Salmon CT. 2004. Guilt, fear, stigma and knowledge gaps: ethical issues in public health communication interventions. Bioethics 18:531–552.

41. Bassett EH, O’Riordan K. 2002. Ethics of Internet research: contesting the human subjects model. Ethics Inf Technol 4:233–247.

42. British Psychological Society. 2013. Ethics Guidelines for Internet-mediated Research. INFo206/1.2013. Leicester, UK, www.bps.org.uk/publications/policy-andguidelines/research-guidelines-policydocuments/research-guidelines-poli.

43. Flicker S, Haans D, Skinner H. 2004. Ethical dilemmas in research on Internet communities. Qual Health Res 14:124–134.

44. Carrion ML. 2017. “You need to do your research”: vaccines, contestable science, and maternal epistemology. Public Underst Sci 96366251772802.

45. Kummervold PE, Schulz WS, Smout E, Fernandez-Luque L, Larson HJ. 2017. Controversial Ebola vaccine trials in Ghana: a thematic analysis of critiques and rebuttals in digital news. BMC Public Health 17:642.

46. Poltorak M, Leach M, Fairhead J, Cassell J. 2005. “MMR talk” and vaccination choices: an ethnographic study in Brighton. Soc Sci Med 61(3):709–719.

47. Dalrymple KE, Young R, Tully M. 2016. Facts, not fear: uncertainty on social media during the 2014 Ebola crisis. Sci Commun 38:442–467.
50. Browne M, Thomson P, Rockloff MJ, Pennycook G. 2015. Going against the herd: psychological and cultural factors underlying the “vaccination confidence gap.” PLOS One 10:e0132562.

51. Fadda M, Depping MK, Schulz PJ. 2015. Addressing issues of vaccination literacy and psychological empowerment in the measles-mumps-rubella (MMR) vaccination decision-making: a qualitative study. BMC Public Health 15:836.

52. Kennedy AM, Brown CJ, Gust DA. 2005. Vaccine beliefs of parents who oppose compulsory vaccination. Public Health Rep 120:252–258.

53. Binyamin B, Bilenko N, Haas EJ, Grotto I, Gdalevich M. 2016. Socioeconomic status and vaccine coverage during wild-type poliovirus emergence in Israel. Epidemiol Infect 144:2840–2847.

54. Velan B. 2016. Vaccine hesitancy as self-determination: an Israeli perspective. Isr J Health Policy Res 5:13.

55. Luthy KE, Beckstrand RL, Callister LC, Cahoon S. 2012. Reasons parents exempt children from receiving immunizations. J Sch Nurs 28:153–160.

56. Funk C, Kennedy B, Heffernon M. 2017. Vast majority of Americans say benefits of childhood vaccines outweigh risks. Pew Research Center, Washington, DC.

57. Peretti-Watel P, Ward JK, Schulz WS, Verger P, Larson HJ. 2015. Vaccine hesitancy: clarifying a theoretical framework for an ambiguous notion. PLOS Curr doi:10.1371/currents.outbreaks.6844c80f9f5b273f34c9f71b7fc289.

58. Tustin JL, Crowcroft NS, Gesink D, Johnson I, Keelan J, Lachapelle B. 2017. Facebook recruitment of vaccine-hesitant Canadian parents: cross-sectional study. JMIR Public Heal Surveill 3:e47.

59. Keelan J, Pavri V, Balakrishnan R, Wilson K. 2010. An analysis of the human papilloma virus vaccine debate on MySpace blogs. Vaccine 28:1535–1540.

60. Bragazzi NL, Barberis I, Rosselli R, Gianfredi V, Nucci D, Moretti M, Salvatori T, Martucci G, Martini M. 2017. How often people Google for vaccination: qualitative and quantitative insights from a systematic search of the web-based activities using Google trends. Hum Vaccin Immunother 13:464–469.

61. McClure CC, Cataldi JR, O’Leary ST. 2017. Vaccine hesitancy: where we are and where we are going. Clin Ther 39:1550–1562.

62. Brennan SE. 2004. How conversation is shaped by visual and spoken evidence, p 95–130. In Trueswell JC, Tanenhaus MK (ed), Approaches to studying world-situated language use. MIT Press, Cambridge, MA.