Published in final edited form as:

Vaccine. 2016 June 14; 34(28): 3225–3228. doi:10.1016/j.vaccine.2016.04.044.

Effective Vaccine Communication during the Disneyland Measles Outbreak

David Andre Broniatowski, Ph.D.,

Department of Engineering Management and Systems Engineering, School of Engineering and Applied Science, The George Washington University, Washington, DC USA

Karen M. Hilyard, Ph.D., and

Department of Health Promotion & Behavior, College of Public Health, University of Georgia, Athens, GA USA

Mark Dredze, Ph.D.

Human Language Technology Center of Excellence, Johns Hopkins University, Baltimore, MD USA

Abstract

Vaccine refusal rates have increased in recent years, highlighting the need for effective risk communication, especially over social media. Fuzzy-trace theory predicts that individuals encode bottom-line meaning ("gist") and statistical information ("verbatim") in parallel and that articles expressing a clear gist will be most compelling. We coded news articles ($n=4,686$) collected during the 2014–2015 Disneyland measles for content including statistics, stories, or opinions containing bottom-line gists regarding vaccines and vaccine-preventable illnesses. We measured the extent to which articles were compelling by how frequently they were shared on Facebook. The most widely shared articles expressed bottom-line opinions, although articles containing statistics were also more likely to be shared than articles lacking statistics. Stories had limited impact on Facebook shares. Results support Fuzzy Trace Theory's predictions regarding the distinct yet parallel impact of categorical gist and statistical verbatim information on public health communication.

Introduction

Fear of vaccination has increased the rate of vaccine refusal in recent years[1]. Herd immunity may not be achieved, exposing vulnerable groups to several infectious diseases[1]. The recent Disneyland measles outbreak brought national attention to this growing problem. The outbreak, which started in December 2014, led to 111 cases in seven states, Canada, and

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Conflict of Interest Statement

No other financial disclosures were reported by the authors of this paper.

Mexico. This is not an isolated example; failure to adhere to vaccination schedules is increasing, even among educated populations[2].

Despite the effectiveness of vaccines, there remain areas with low uptake rates, reflecting the importance of vaccine risk communication. American Academy of Pediatrics guidelines suggest that pediatricians “share honestly what is and is not known about the risks and benefits of the vaccine in question, attempt to understand the parent's concerns about immunization, and attempt to correct any misperceptions and misinformation.”[3] However, these recommendations do not specify the most effective manner for physicians to communicate the latest evidence-based statistics – the “risks and benefits” – associated with vaccines and their refusal. Furthermore, communicating statistical information on its own may be ineffective or even counterproductive[4–6], and controversy has surrounded evidence that a story may be more effective than communicating statistical data[7–9].

Fuzzy-Trace Theory

Public understanding of the meaning of risks associated with vaccination is central to communications that address vaccine refusal. Thus, we draw upon Fuzzy Trace Theory (FTT) – a leading theory of medical decision-making, which explains the process by which individuals derive meaning from information they are given[6]. Specifically, FTT emphasizes differences in the way people process precise details such as statistics (“verbatim”), versus simple bottom-line meaning (“gist”)[10]. Gists emphasize categorical contrasts between decision options (e.g., “There is no chance that mercury in vaccines can cause autism, since it is not in vaccines anymore” or “if you do not vaccinate your child, there is a real chance that they could get sick”). Gist is expected to be more compelling than verbatim, although FTT holds that both are processed in parallel[10–12].

Social Media Analysis

Vaccine devoted a special issue to the influence of social media on patients’ vaccination intentions and behaviors,[1] and social media use continues to rise, led by Facebook. More than 30% of the general U.S. population report getting news from Facebook. Some groups receive a majority of their news from social media,[13] and these articles inform decisions about a range of issues, prompting health behavior change[14,15]. Thus, social media provide an ideal forum to study health communications, motivating an analysis of the factors driving online sharing of articles related to vaccination.

Material and methods

This retrospective observational study was designed to test FTT’s prediction that vaccine-relevant articles expressing a gist are more likely to be shared on Facebook when compared to articles expressing verbatim statistics.

We collected a set of 39,351 news articles with 4,000 words or fewer, containing vaccine-related keywords published during the Disneyland measles outbreak – November 18, 2014 through March 26, 2015 – using news search application protocol interfaces (APIs), such as Google News and Bing News (Supplemental Material). We asked workers using Amazon’s Mechanical Turk to indicate whether articles were relevant to vaccination and contained

statistics, stories, or a gist (operationalized as positive, negative, or no opinion about those who endorse or oppose vaccination, see Supplemental Material). We used the public Facebook API to measure the number of times these articles were shared, each article's length, whether or not an image was present, and each article's readability (Flesch-Kincaid Index).

Since most articles are never shared on Facebook (see Figure 1), we first conducted a logistic regression analysis to examine the effects of stories, statistics, and gist, on whether an article was shared at least once, controlling for article length, presence of an image, and readability. The presence of images, stories, statistics, and gists were coded as 0 = not present in article, 1 = present in article, and article length was measured in words. We next conducted a linear regression on those articles that were shared at least once, after applying a logarithmic transform to the Facebook shares data to correct for positive skew. We applied the same regression techniques to articles containing gists to determine if article sentiment (positive, negative, or none) was associated with more sharing on Facebook.

Results

We coded 6,158 articles selected at random from our dataset, of which 4,706 were relevant to vaccination. Of these, data were unavailable for 125 articles. 763 articles contained a gist.

We verified that articles expressing an opinion contained a gist by asking 210 workers to indicate whether articles also contained a bottom-line conclusion regarding vaccines or vaccine-preventable illnesses. 186 (89%) articles were classified concordantly between gist and opinion, with Cohen's $\kappa = 0.64$, indicating substantial agreement. We also tested 526 articles for inter-annotator agreement with Fleiss' κ for presence of statistics, 0.26 for stories, and 0.38 for gists.

After controlling for article length, readability, and presence of images, we found that statistics and gists, but not stories, were significant predictors of whether an article was shared at least once (see Table 1). Furthermore, linear regression showed that articles with gists were shared 2.4 times more often, on average, than articles without gists, $t(1678) = 2.93$, $p=0.003$. Results replicated across several statistical methodologies (see Supplemental Material). Among articles with gists that were shared at least once, linear regression showed that those expressing positive opinions about both those who endorse and those who oppose vaccination were 57.8 times more likely, on average, to be shared than articles with other sentiments, $t(256) = 2.50$, $p=0.01$. We found no significant effect of credibility of source (see Supplemental Material).

Discussion

Our results provide evidence supporting FTT's predictions[10–12]. Articles expressing a gist (bottom-line meaning) were shared most often. Articles containing verbatim statistics were also shared, although not as frequently as articles expressing a gist, and the effects of gist and verbatim were distinct. Stories did not significantly increase Facebook shares, suggesting that stories may only be effective to the extent that they serve to communicate a clear gist[10]. Furthermore, consistent with decades of prior research [16] the most popular

articles acknowledged both sides of the argument, indicating that although the the same information was shared, meanings emphasized may have differed.

Both social media and provider recommendations can influence parental decision-making about vaccination, and our findings suggest practical implications and future research questions for public health communicators and clinicians. Specifically, our results can inform the content of public health communications that aim to use social media for outreach. Public health officials seeking to increase vaccine uptake must recognize that verbatim statistical facts alone may not be persuasive. Indeed, although people generally encode both verbatim and gist representations of familiar information, clarifying and emphasizing the gist of unfamiliar information can facilitate its comprehension.

Communication strategies that resonate on social media may also succeed in interactions between health care providers and patients. Although not a cure-all for vaccine refusal, more effective, targeted communication from providers can have a desirable impact on these decisions. Our findings suggest the need for further research into possible applications for explicit inclusion of gist in both patient-provider interactions and in communication materials directed at patients. For example Teach-Back, a method to increase patient comprehension, recall, and adherence, has been successfully incorporated into communication training for healthcare providers[17]. We hypothesize that providers may benefit from similar training in how to include gist along with statistics. Inspired by successful applications of FTT to other public health problems[18,19], we propose that future research focus on a conceptual model that can help healthcare providers to communicate evidence-based findings in a manner that also emphasizes gist. Like the Teach-Back Method[17], this proposed “gist communication framework” uses a series of short scripts healthcare providers can employ across health topics and conversations (Figure 2), and need not require lengthy conversation. The technique could be used both during in-person provider-patient interactions and in the preparation of print and digital messages targeting patients. For example, a pediatrician addressing a vaccine hesitant parent about measles might use an evidence-based *verbatim* statement: “Vaccines, like any medicine, can have side effects, but most children who get the MMR shot have no side effects; however, measles can lead to pneumonia, deafness, lifelong brain damage, or even death and almost one-third of children with measles have to be hospitalized.”[20] but then could follow that with a scripted phrase, such as: “So what I tell my patients is...” and conclude with a categorical *gist*: “Taking any risk that your child could get the measles and suffer serious complications just isn’t worth it. Vaccination is the best way to protect your child.”

Conclusions

FTT is an effective framework for understanding medical decision-making. Our results suggest it can help explain the persuasiveness of social media messages related to vaccination. In addition, stories may not be effective unless they convey a gist. Finally, acknowledging the occasional occurrence of adverse vaccine events may increase credibility, *inoculating* patients with counterarguments. Future research should further develop practical tools that may assist healthcare providers and public health communicators in increasing vaccination rates among hesitant patients.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Dredze has received consulting fees from Directing Medicine and Sickweather, companies that use social media for public health.

Dredze, Broniatowski, and Hilyard are supported by NIH under award number 1R01GM114771-01. The authors would like to thank Dr. Rebecca Begtrup, Dr. Eili Klein, and Dr. Sandra Crouse Quinn for their helpful comments and feedback.

References

1. Betsch C, Sachse K. Special Issue: The Role of Internet Use in Vaccination Decisions. *Vaccine*. 2012; 30(25):3723–3818. [PubMed: 22472790]
2. Bass PF. Vaccine refusal. *Contempor Pediatr*. 2015; 32(7)
3. Diekema DS. Responding to parental refusals of immunization of children. *Pediatr*. 2005; 115:1428–1431.
4. De Wit JB, Das E, Vet R. What works best: objective statistics or a personal testimonial? An assessment of the persuasive effects of different types of message evidence on risk perception. *Health Psychol*. 2008; 27(1):110. [PubMed: 18230021]
5. Murphy ST, Frank LB, Chatterjee JS, Moran MB, Zhao N, Amezola de Herrera P, Baezconde-Garbanati LA. Comparing the Relative Efficacy of Narrative vs Nonnarrative Health Messages in Reducing Health Disparities Using a Randomized Trial. *Am J Public Health*. 2015; 105(10):2117–2123. [PubMed: 25905845]
6. Betsch C, Renkewitz F, Haase N. 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 Mak*. 2013; 33(1):14–25.
7. Winterbottom A, Bekker HL, Conner M, Mooney A. Does narrative information bias individual's decision making? A systematic review. *Soc Sci Med*. 2008; 67(12):2079–2088. [PubMed: 18951673]
8. Bekker HL, Winterbottom AE, Butow P, Dillard AJ, Feldman-Stewart D, Fowler FJ, Jibaja-Weiss ML, Shaffer VA, Volk RJ. Do personal stories make patient decision aids more effective? A critical review of theory and evidence. *BMC Med Inform Decis Mak*. 2013; 13(Suppl 2):S9. [PubMed: 24625283]
9. Shaffer VA, Zikmund-Fisher BJ. All Stories Are Not Alike A Purpose-, Content-, and Valence-Based Taxonomy of Patient Narratives in Decision Aids. *Med Decis Mak*. 2013; 33(1):4–13.
10. Reyna VF. A theory of medical decision making and health: fuzzy trace theory. *Med Decis Mak*. 2008; 28(6):850–865.
11. Reyna VF. Risk perception and communication in vaccination decisions: a fuzzy-trace theory approach. *Vaccine*. 2012; 30(25):3790–3797. [PubMed: 22133507]
12. Reyna VF, Adam MB. Fuzzy-trace theory, risk communication, and product labeling in sexually transmitted diseases. *Risk Anal*. 2003; 23(2):325–342. [PubMed: 12731817]
13. Anderson, M.; Caumont, A. How social media is reshaping news. Washington: Pew Center; 2014 Sep 24.
14. Cameron AM, Massie A, Alexander C, et al. Social media and organ donor registration: the Facebook effect. *Am J Transpl*. 2013; 13(8):2059–2065.
15. Kata A. Anti-vaccine activists, Web 2.0, and the postmodern paradigm – An overview of tactics and tropes used online by the anti-vaccination movement. *Vaccine*. 2012; 30(25):3778–3789. [PubMed: 22172504]
16. McGuire WJ. The effectiveness of supportive and refutational defenses in immunizing and restoring beliefs against persuasion. *Sociometry*. 1961 Jun 1; 24(2):184–197.

17. Reyna VF, Mills BA. Theoretically motivated interventions for reducing sexual risk taking in adolescence: A randomized controlled experiment applying fuzzy-trace theory. *J Exp Psychol Gen.* 2014; 143(4):1627–1648. [PubMed: 24773191]
18. Wolfe CR, Reyna VF, Widmer CL, Cedillos EM, Fisher CR, Brust-Renck PG, Weil AM. Efficacy of a Web-Based Intelligent Tutoring System for Communicating Genetic Risk of Breast Cancer A Fuzzy-Trace Theory Approach. *Med Decis Mak.* 2014; 35(1):46–59.
19. Jager AJ, Wynia MK. Who Gets a Teach-Back? Patient-Reported Incidence of Experiencing a Teach-Back. *J Health Commun.* 2012; 17(sup3):294–230. Weiss. [PubMed: 23030577]
20. Measles and the vaccine (shot) to prevent it: fact sheet for parents. Atlanta: Centers for Disease Control and Prevention; 2015 Nov. National Center for Respiratory and Infectious Diseases. from <http://www.cdc.gov/vaccines/vpd-vac/measles/fs-parents.html> [Retrieved January 22, 2015]

Figure 1.

Proportion of articles shared at least one, ten, 100, and 1,000 times on Facebook. Error bars reflect one standard error.

Proposed Gist Communication Framework

Patient-provider communication technique based on Fuzzy-Trace Theory* [10, 11]

Figure 2.
 "Gist Communication Framework" emphasizing the link between evidence-based findings and the bottom-line meaning to the patient

Table 1

Coefficients of logistic regression analysis for whether an article was shared at least once on Facebook ($n=4580$, $df=10$).

	β	SE β	z value	OR
Length	-5.56×10^{-4}	8.93×10^{-5}	-6.22^{***}	1.00
Readability	-7.23×10^{-4}	1.49×10^{-3}	-0.49	1.00
Image	0.59	0.09	6.91^{***}	1.80
Stories	0.34	0.19	1.82	1.41
Statistics	0.29	0.08	3.48^{***}	1.33
Gist	0.82	0.15	5.36^{***}	2.27
Stories * Statistics	0.05	0.22	0.24	1.05
Stories * Gist	0.25	0.32	0.80	1.29
Statistics * Gist	-0.17	0.20	-0.85	0.85
Stories * Statistics * Gist	-0.35	0.40	-0.89	0.70
(Intercept)	-1.08	0.12	-8.91^{***}	

Note.

$***$
= $p < 0.001$.

β = logistic regression coefficient; SE β = standard error of β ; OR = Odds Ratio