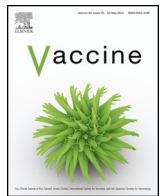




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Short communication

Effective vaccine communication during the disneyland measles outbreak

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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 those articles expressing a clear gist will be most compelling. We coded news articles ($n = 4686$) 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.

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1. 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 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].

1.1. 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].

1.2. Social media analysis

Vaccine devoted a special issue to the influence of social media on patients' vaccination intentions and behaviors, [1] and social

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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.

2. 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 4000 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 Fig. 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.

3. Results

We coded 6158 articles selected at random from our dataset, of which 4706 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' $\kappa \equiv 0.38$ 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, $t_{1678} Y = Y2.93$, $p = 0.003$. 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

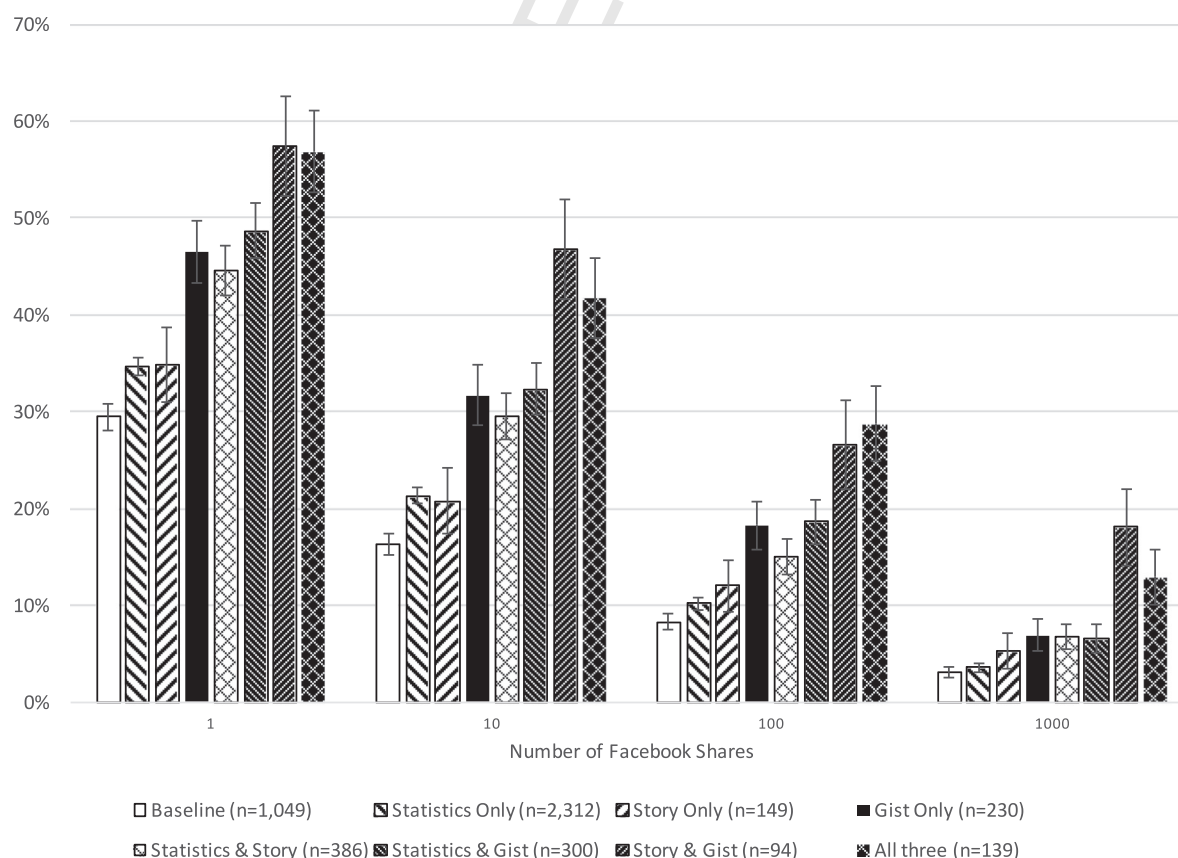


Fig. 1. Proportion of articles shared at least one, 10, 100, and 1000 times on Facebook. Error bars reflect one standard error.

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