Can communicating the gist combat systematic online distortions of public opinion on health topics?
(with new insights from COVID19)

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Setting: Russian trolls and bots amplify the vaccine debate

Likelihood vs Type of Bot: Social spambots, Traditional spambots, Congressional list russian trolls, Content polluters, Sophisticated bots, NBC russian trolls.
Legend: Contains vaccine keyword; Contains vaccine keyword and word starting with "vax" or "vacc"
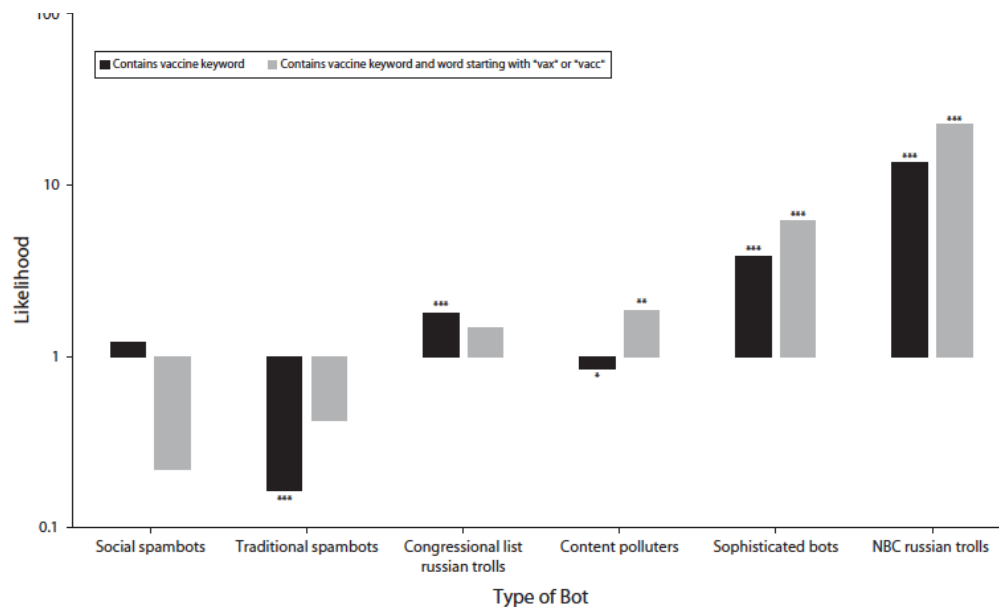
TABLE 1—Proportions of Polarized and Antivaccine Tweets by User Type: July 14, 2014–September 26, 2017

User Type	Polarized, %	Antivaccine, %
Assorted users, bot score, %		
< 20	31	35
20–80	39***	60***
> 80	26	49*,a
Unknown	37*,a	62***
Known bots and trolls		
NBC Russian trolls[20]	20*,a	47
Content polluters[21]	38	60***
Fake followers[22]	0	NA
Traditional spambots[23,24]	3***	0
Social spambots[23,24]	18**	56*,a
Sophisticated bots[25]	28	44
Congressional list Russian trolls[26]	39	48

Broniatowski, D. A., Jamison, A. M., Qi, S., AlKulaib, L., Chen, T., Benton, A., Quinn, S. C., Dredze, M. (2018). Weaponized Health Communication: Twitter Bots and Russian Trolls Amplify the Vaccine Debate. *American Journal of Public Health*, 108(10), 1378–1384.

Novel Findings Pertaining to COVID-19 (under review, joint with A. Caliskan, GWU CS)

- Using a method to extract biases implicit in large text corpora (Caliskan et al., 2017) we examined biases in a dataset of tweets containing anti-Chinese hashtags (e.g., #chinavirus) from early March 2020
  - Method validated against existing Russian information operations accurately detecting anti-Muslim sentiment and anti-Clinton sentiment in 2016 election tweets

- As expected, China was associated with "unpleasantness" and "panic"

- The USA was also associated with "panic"

- Surprisingly, Russia was associated with "calm" and "pleasantness"

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Panic (d)*	-1.17 to -0.72	-0.72 to -0.27	-0.27 to 0.19	0.19 to 0.64	0.64 to 1.09	1.09 to 1.55
Unpleasant (d)*	-1.24 to -0.83	-0.83 to -0.41	-0.41 to 0.00	0.00 to 0.41	0.41 to 0.83	0.83 to 1.24
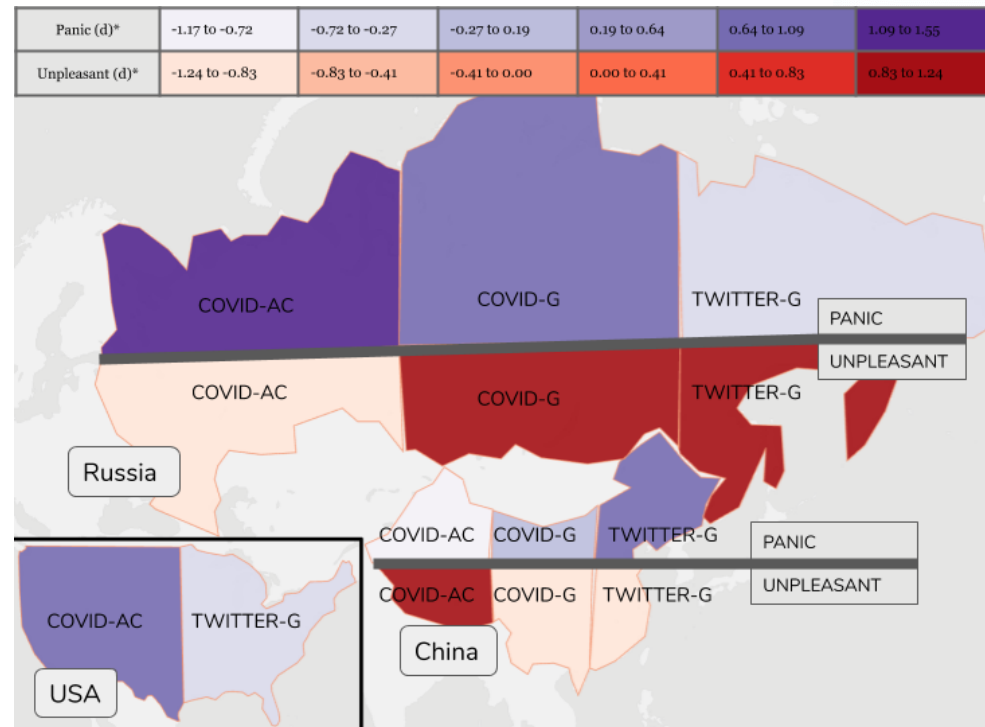
The view from China

- In July 2018, a report came out showing that a Chinese firm, Changchun Changsheng Biotechnologies, had manufactured ineffective rabies vaccines

- We analyzed the response to this incident using data from Weibo – the most popular microblogging platform in China

- Our findings suggest that public trust in government health directives had already been eroding prior to the COVID-19 outbreak

The King of Vaccines: The Chinese Firm Embroiled in the Vaccine Scandal

Category: Corruption   Tags: Changsheng Biotechnology Co Ltd / China / Defective Vaccines / Sun Xianze

A Chinese report on the 'King of Vaccines' revealed a recent vaccine scandal involving a major manufacturer in China, Changsheng Bio-technology Co., Ltd. (image: pixabay / CC0 1.0)

Hu, D., Martin, C., Dredze, M., & Broniatowski, D. A. (2020). Chinese social media suggest decreased vaccine acceptance in China: An observational study on Weibo following the 2018 Changchun Changsheng vaccine incident. *Vaccine*, *38*(13), 2764–2770. https://doi.org/10.1016/j.vaccine.2020.02.027

The view from China

Percentage Trends of 6 Categories In Three Periods, 2018

Legend: July 1 - July 10, July 11- July 20, July 21- July 31

Percentage Trends of 6 Categories, Comparing Pre-Incident and One Year After the Incident
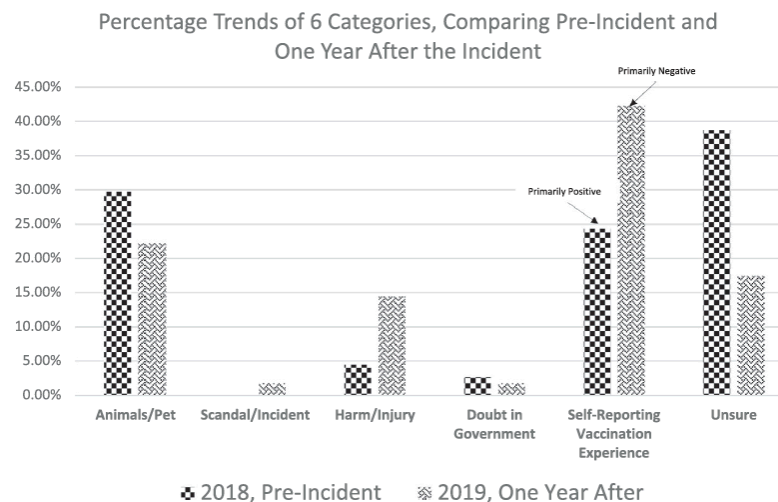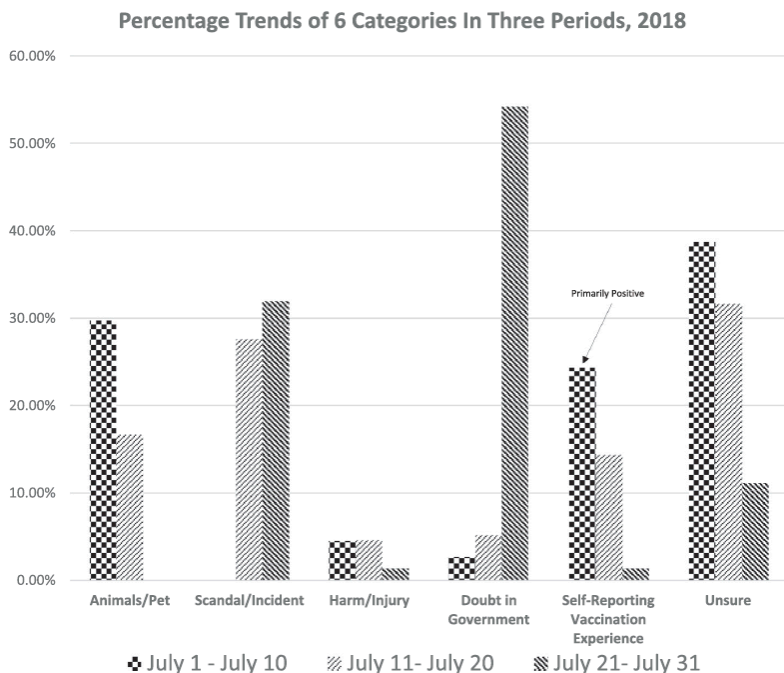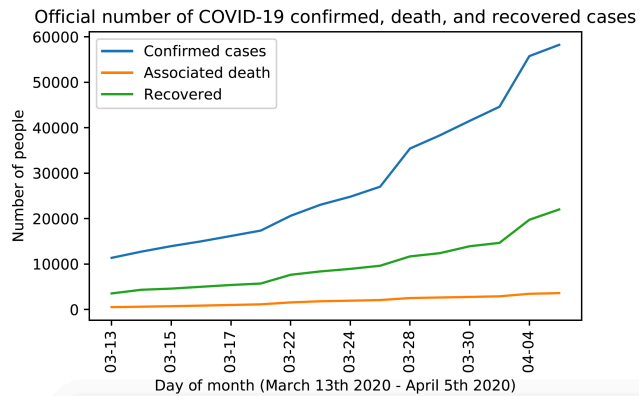
Legend: 2018, Pre-Incident, 2019, One Year After

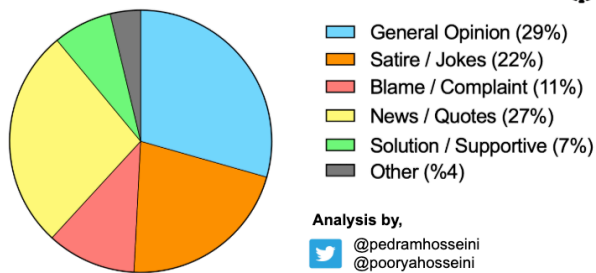Fig. 3. Shift of Distribution of 6 categories, Pre-incident Data vs. 2019 Data.

Hu, D., Martin, C., Dredze, M., & Broniatowski, D. A. (2020). Chinese social media suggest decreased vaccine acceptance in China: An observational study on Weibo following the 2018 Changchun Changsheng vaccine incident. *Vaccine*, *38*(13), 2764–2770. https://doi.org/10.1016/j.vaccine.2020.02.027

Official number of COVID-19 confirmed, death, and recovered cases

Topic analysis of 50,000 Tweets in Persian/Farsi on COVID-19

- General Opinion (29%)
- Satire / Jokes (22%)
- Blame / Complaint (11%)
- News / Quotes (27%)
- Solution / Supportive (7%)
- Other (%4)

Analysis by,

@pedramhosseini
@pooryahosseini

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The view from Iran: Novel Findings Pertaining to COVID-19 (joint with Pedram Hosseini and Poorya Hosseini)

- Persian tweets about COVID-19 seem to contain a significant proportion of satire
- Conspiracy theories are being used to promote social distancing
  - E.g., the US created COVID-19 as an aerosolized bioweapon. Therefore, stay home to save lives and avoid spreading the disease.
- Unlike other countries, Iranian society does not seem to be mobilizing to combat COVID-19 to the same degree.
  - These techniques seem to be ineffective – conversation volume has decreased while number of Iranian cases continues to grow exponentially
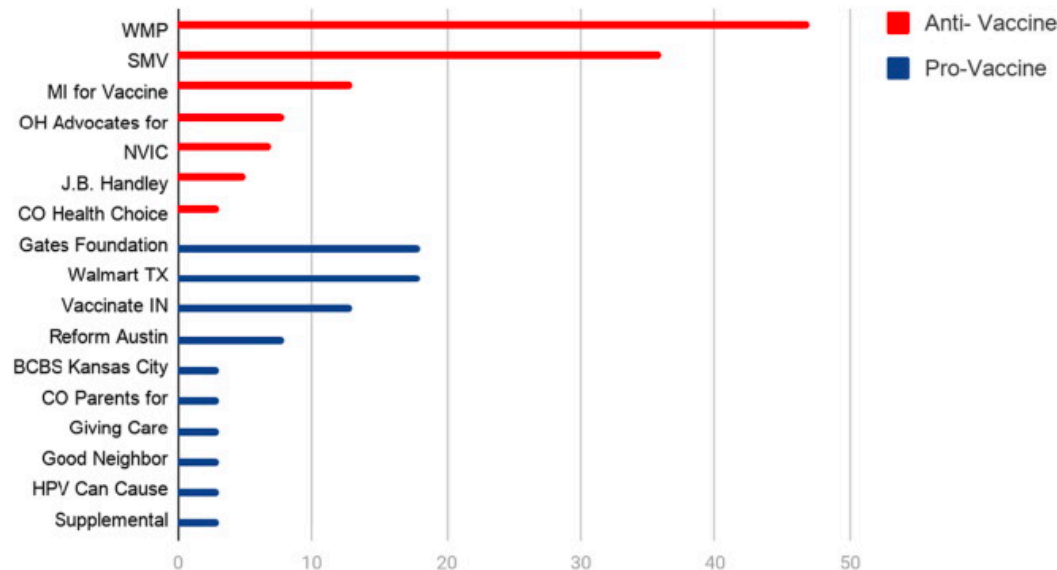
Setting: Two Ad Buyers Generate 54% of all anti-vaccine ads

Buyers with >2 Ads, by Type

- Anti- Vaccine
- Pro-Vaccine

Top 5 anti-vax = 75% share; top 5 pro-vax = 35% share

WMP = World Mercury Project

SMP = Stop Mandatory Vaccination

Compared to pro-vaccine ads, anti-Vaccine Ads were more likely to target women of childbearing age, vaccines in general, spent more money, and generated more impressions

Jamison, A. M., Broniatowski, D. A., Dredze, M., Wood-Doughty, Z., Khan, D., & Quinn, S. C. (2019). Vaccine-related advertising in the Facebook Ad Archive. *Vaccine*. https://doi.org/10.1016/j.vaccine.2019.10.066

Organized Anti-Vaxx Campaigns

- Anti-vaccination social media campaigns are generally well-organized and manipulate facts to fit an existing narrative

- "REPORT from Physicians in the Crop-Sprayed Villages regarding Dengue-Zika, microcephaly, and mass-spraying with chemical poisons"

  - http://www.reduas.com.ar/wp-content/uploads/downloads/2016/02/Informe-Zika-de-Reduas_TRAD.pdf

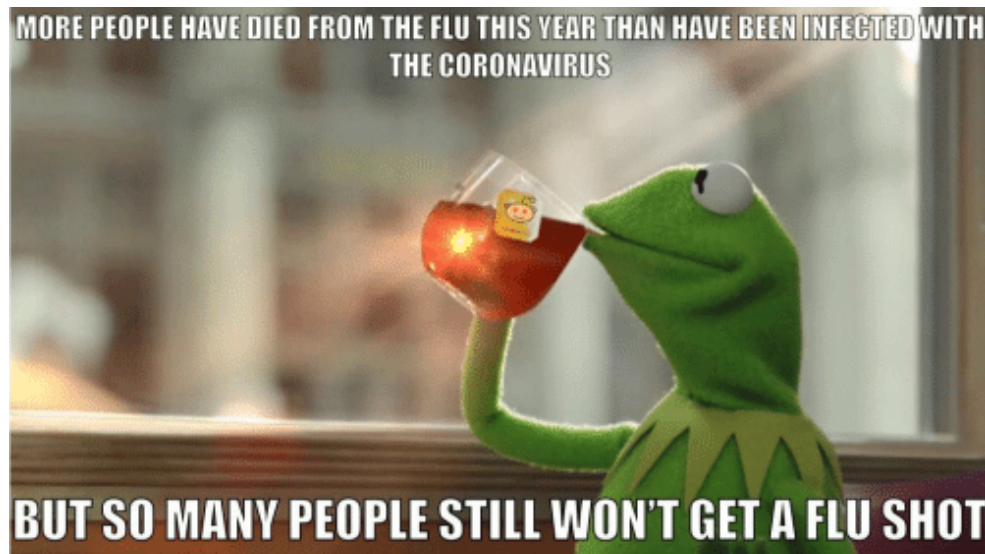

Monsanto does not make or use pyriproxifen

Pyriproxifen doesn't cause microcephaly

Spurious Correlation: Mosquitos & larvicide

Dredze, M., Broniatowski, D. A., & Hilyard, K. M. (2016). Zika vaccine misconceptions: A social media analysis. *Vaccine*. http://doi.org/10.1016/j.vaccine.2016.05.008

COVID-19 Conspiracies and "Facts Out of Place" (unpublished, joint with M. Dredze, JHU and A. Jamison and S. C. Quinn, UMD)

MORE PEOPLE HAVE DIED FROM THE FLU THIS YEAR THAN HAVE BEEN INFECTED WITH THE CORONAVIRUS

BUT SO MANY PEOPLE STILL WON'T GET A FLU SHOT

Get a flu shot!

- We identified the 2,000 most active vaccine-related Twitter accounts in early 2020 (Jan. – Mar.)

- Anti-vaccine accounts: shared conspiracy theories related to the disease's origin, rumors about authoritarian Chinese containment strategies, and made comparisons to other disease outbreaks.

- Pro-vaccine accounts: shared news and updates related to COVID-19, emphasize the importance of "facts not fear" and evidence-based responses to the outbreak, and criticized the spread of viral misinformation and racial stereotypes.

- Both pro-vaccine and anti-vaccine accounts shared narratives emphasizing the greater risk of influenza and warning the news media about engaging in fear-mongering.
  - Both pro-vaccine and anti-vaccine Twitter accounts were linked to misleading claims about COVID-19.
  - Not all misinformation appears as conspiracy theories, the impact of these "facts out of place" may be just as dangerous to a society preparing for a pandemic.

Effect of Narratives on Health Behaviors

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Contents lists available at SciVerse ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

ELSEVIER

Opportunities and challenges of Web 2.0 for vaccination decisions☆

Cornelia Betsch [a,*], Noel T. Brewer [b], Pauline Brocard [c], Patrick Davies [d], Wolfgang Gaissmaier [e], Niels Haase [a], Julie Leask [f], Frank Renkewitz [a], Britta Renner [g], Valerie F. Reyna [h], Constanze Rossmann [i], Katharina Sachse [j], Alexander Schachinger [k], Michael Siegrist [l], Marybelle Stryk [m]

- Narratives have inherent advantages over other communication formats…[and] include all of the key elements of memorable messages: They are easy to understand, concrete, credible … and highly emotional. These qualities make this type of information compelling…" (p. 3730)

- Examples: anti—vaccination tropes (e.g., Kata, 2012)

Kata, A. (2012). Anti-vaccine activists, Web 2.0, and the postmodern paradigm–An overview of tactics and tropes used online by the anti-vaccination movement. *Vaccine*, *30*(25), 3778–3789.

Statistics, Stories…. or gist?

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- Ongoing debate: Statistics vs. stories ("either-or") (De Wit, Das, & Vet, 2008)
  - Prominent health officials want to "present the facts" (i.e., statistical data)?
    - Hesitance to include stories because of concerns of appearing biased
- Fuzzy Trace Theory: Gist and verbatim encoded **in parallel**
  - Verbatim representation (statistical details)
    - "Measles can lead to pneumonia, deafness, lifelong brain damage, and even death, and almost 1/3 of children with measles have to be hospitalized"
  - Gist: Communicates bottom-line meaning
    - "Taking any risk that your child could get the measles and suffer serious complications isn't worth it. Vaccination is the best way to protect your child"
  - Stories are effective because they communicate a gist.
    - Also cue **motivationally relevant moral and social principles**
- For narratives, "gist representation is a coherent story about causality"
  - Narratives that "jump to conclusions" or "connect the dots" satisfy a "meaning threat"
- According to Fuzzy-Trace Theory messages that produce more causally coherent and meaningful gist will be more influential (even if they are not factually accurate!).

Reyna, V. F. (2012). Risk perception and communication in vaccination decisions: A fuzzy-trace theory approach. *Vaccine*, *30*(25), 3790–3797.

Analysis of measles media coverage

- Coded 4,581 out of a collection of 39,351 outbreak-related articles published from November 2014 to March 2015

- Measured shares on Facebook

- Used M-Turk to categorize article content:

- 1) statistics about viruses or vaccines
  2) "gist", or bottom line meaning
  - Positive or negative summary opinion about endorsing or opposing vaccination

- 3) Other expected covariates based on prior literature

Broniatowski, D. A., Hilyard, K. M., & Dredze, M. (2016). Effective vaccine communication during the disneyland measles outbreak. *Vaccine*. http://doi.org/10.1016/j.vaccine.2016.04.044

What led to article shares:

- Results are consistent with Fuzzy Trace Theory
  - Significant effects of gist and verbatim, but NOT stories
- Among articles shared once (n=257), articles with gists were shared 2.4 times more often, on average, than articles without gists, *t(1678) = 2.93, p=0.003.*
  - Articles expressing positive opinions about those endorsing vaccination AND those opposing vaccination were 57.8 times more often

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. $^{***} = p < 0.001$. $\beta =$ logistic regression coefficient; SE $\beta =$ standard error of β; OR = Odds Ratio.

Broniatowski, D. A., Hilyard, K. M., & Dredze, M. (2016). Effective vaccine communication during the disneyland measles outbreak. *Vaccine*. http://doi.org/10.1016/j.vaccine.2016.04.044

Replication on Twitter data

Table 5 Best-fitting linear regression model predicting number of retweets per follower for tweets with at least one retweet

	R^2		MSE	
	Training	Holdout	Training	Holdout
Null	0.00	− 0.01	3.92	4.25
User verification only	0.19	0.22	3.19	3.29
Round 1 (LASSO)	0.23	0.24	3.01	3.21
Round 2 (complex OLS)	0.24	0.25	2.97	3.16
Round 3 (simple OLS)	0.22	0.25	3.07	3.16
Saturated	0.68	− 1.38	1.25	5.81

R^2 the coefficient of determination, *MSE* mean squared error, *OLS* ordinary least squares. Round 1 = the model fit by LASSO regression. Round 2 = an OLS regression model retaining only variables that replicated across the LASSO and bidirectional elimination methods. Round 3 = an OLS regression model retaining only variables that were significant in the explanatory model after controlling for multiple comparisons using the Holm-Bonferroni procedure

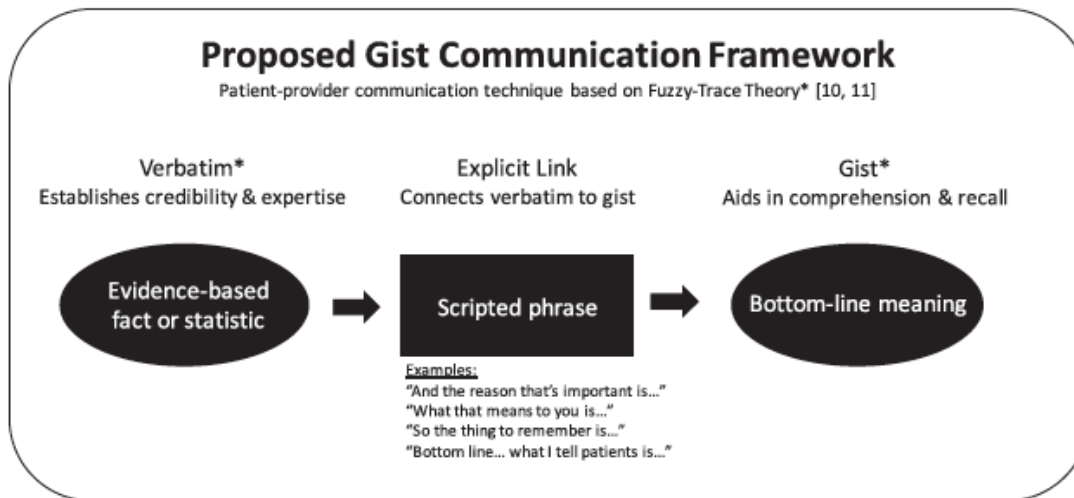| Covariate	β (*SE*)	t
User verified?	− 2.51 (0.01)	− 18.40***
Topic 2 *Vaccines cause autism*	0.63 (0.14)	4.49***
Topic 17 *Pet vaccines*	0.52 (0.14)	3.75***
Topic 2 × verbatim	− 0.06 (0.01)	− 5.01***
(Intercept)	− 2.61 (0.79)	− 3.32***

β Linear regression coefficient. *SE* standard error. Coefficients represent an increase in retweets per follower (measured in logits) for each unit increase in the dependent variable. All topic proportions are also measured in logits. User Verified? is a dummy variable indicating whether the account tweeting the message corresponded to a verified user (1) or not (0). Total model $R^2 = 0.23$

***$p < 0.001$

- N=1,388 tweets with at least one retweet and one follower

Implications

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

Verbatim*
Establishes credibility & expertise

Explicit Link
Connects verbatim to gist

Gist*
Aids in comprehension & recall

Evidence-based fact or statistic → Scripted phrase → Bottom-line meaning

Examples:
"And the reason that's important is…"
"What that means to you is…"
"So the thing to remember is…"
"Bottom line… what I tell patients is…"

Broniatowski, D. A., Hilyard, K. M., & Dredze, M. (2016). Effective vaccine communication during the disneyland measles outbreak. *Vaccine*. http://doi.org/10.1016/j.vaccine.2016.04.044

- Fuzzy-Trace Theory's predictions regarding the effects of gist on online information spread about vaccination replicate across multiple platforms

- Causal gist, in particular, seems to be associated with efficacy of online messages
  - **Precise facts matter too!**
    - However effect size is small, consistent with preference for gist processing
  - Motivational factors, e.g., compelling media, are significant too but only for getting "over the hump" from 0 to 1 shares.
  - Without a gist, "clickbait" will not propagate.

- Implications: Effective online messaging communicates a clear, causal gist. It answers "why" to otherwise mysterious events.

Conclusions

- The social media landscape combines automated and "sincere" account-holders
- These account holders may have a range of hidden-agendas.
  - State-sponsored trolling
  - Genuine believers
  - Marketing alternative products and other pecuniary interests
  - Spreading spam
  - Spreading malware
- Public health communicators must know and adapt to this changing landscape
- Leading theories, such as Fuzzy-Trace Theory, suggest promising areas for future research
- Questions?: broniatowski@gwu.edu