Conspiracy Talk on Social Media: Collective Sensemaking during a Public Health Crisis

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Conspiracy theories have gained much academic and media attention recently, due to their large impact on public events. Crisis informatics researchers have examined conspiracy theories as a type of rumor. However, little is known about how conspiracy theories are produced and developed on social media. We present a qualitative study of conspiracy theorizing on Reddit during a public health crisis—the Zika virus outbreak. Using a mixed-methods approach including content analysis and discourse analysis, we identified types of conspiracy theories that appeared on Reddit in response to the Zika crisis, the conditions under which Zika conspiracy theories emerge, and the particular discursive strategies through which Zika conspiracy theories developed in online forums. Our analysis shows that conspiracy talk emerged as people attempted to make sense of a public health crisis, reflecting their emergent information needs and their pervasive distrust in formal sources of Zika information. Practical implications for social computing researchers, health practitioners, and policymakers are discussed.

CCS Concepts: • **Human-centered computing → Human computer interaction (HCI)**; *Empirical studies in HCI*

KEYWORDS: Crisis informatics; epidemic crisis; Zika; conspiracy theory; conspiracy theorizing; social computing; social computing and health; Reddit; sensemaking; public health informatics

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1 INTRODUCTION

Recently widespread rumors have been found on social media during crisis events [32,62]. 'Rumor' is defined as "*a recurrent form of communication through which men (and women) caught together in an ambiguous situation attempt to construct a meaningful interpretation of it by pooling their intellectual resources*" [66]. In particular, conspiracy theories, a distinct type of rumor, circulate for long periods of time and exert huge impacts on society [60,63]. While many definitions of 'conspiracy theory' exist, we adopt Brian Keeley's definition: "*a conspiracy theory is a proposed explanation of some historical event (or events) in terms of the significant causal agency of a relatively small group of persons, the conspirators, acting in secret*" [35]. Conspiracy theories can undermine democratic conversation and potentially fuel violence [64].

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Conspiracy theories related to health and disease are prevalent and can have severe consequences for individuals. For example, belief in a conspiracy theory that HIV was man-made for the purpose of genocide led some AIDS patients to refuse crucial testing and treatments [34]. Widespread belief in conspiracy theories in times of disease outbreaks, epidemics, and pandemics can easily cause public panic and increase the death toll [49]. Despite the emerging body of research on conspiracy theories related to other types of crises [60,63] and the increasing role that social media plays in the development and spread of conspiracy theories related to health, little attention has been paid to the propagation of public health-related conspiracy theories on social media within HCI or beyond.

In this paper, we use the terms 'conspiracy theorizing talk' and 'conspiracy talk' to refer to the specific conversation that takes place about existing or potential conspiracy theories. We study this conspiracy talk in the context of the Zika epidemic that broke out in early 2016 [2]. Our operational definition of conspiracy theories related to public health crises sees such theories as including three essential factors. 1) Conspiracy theories about public health crises include an explanation of the causality behind an event. 2) In the explanation, there are primary actors, which can be either individuals or organizations, taking secretive actions that are unknowable to the public. The primary actors are 'the Other,' as opposed to the self or members of one's own group. This is because conspiracy theories often originate from people's imagination of the unknowable, which usually refers to the Other rather than the individuals themselves. 3) In the explanation, the secretive actions must have malicious purposes to promote primary actors' own agenda at the cost of harming the greater good. An exemplar of a conspiracy theory containing these three conditions is that the Ebola virus is "a bioweapon designed by the United States military to depopulate the planet [24]." This conspiracy theory contains all the three conditions, including an explanation of why the Ebola virus spread, the U.S. military as the primary actor, and the malicious purpose of mass murder.

Our study has three research questions centered on conspiracy theorizing talk on social media during the Zika pandemic. 1) What were the conspiracy theories proposed about the Zika crisis? 2) Under what circumstances were these conspiracy theories proposed? 3) What strategies do people use to develop a conspiracy theory about a public health crisis? To answer these questions, we collected Zika-related discussions on Reddit, used content analysis to identify instances of conspiracy talk, and employed discourse analysis to understand the production and development of conspiracy theories about Zika. Using collective sensemaking as the analytical framework, we study how people proposed various types of conspiracy theories to cope with perceived ambiguity about Zika, and identify four conditions that triggered people to propose conspiracy theories as part of their sensemaking activities. We further propose 12 discursive strategies that people employed in developing a complete conspiracy theory of the current situation.

The contributions of the paper are three-fold. First, our detailed analysis of conspiracy theorizing talk on social media as a form of collective sensemaking contributes to the crisis informatics literature on how people use social media to respond to crisis events. Second, studying the antecedent situational factors and the genesis of conspiracy theories has practical value because there are large gaps in availability and uptake of accurate information about epidemic crises between public health authorities and the public. Our work provides valuable insights to both researchers and public health authorities that aim to promote information exchange between people with diverse ideologies. Third, by understanding how and why people come up with and develop conspiracy theories about Zika from the lens of collective sensemaking, this study provides empirical insights for policy-makers to monitor the development of conspiracy narratives on social media.

2 BACKGROUND

Zika virus was first discovered in Uganda in 1947, but remained relatively unknown for decades [72]. In October 2015, Brazil reported an increasing number of newborns with microcephaly—a medical condition in which a newborn baby's head is smaller than expected because their brain has not developed properly in utero. It was reported that mothers of these affected Brazilian newborns were in the first trimester of pregnancy during a Zika epidemic in Brazil in March 2015. By the end of 2015, 4180 cases of suspected microcephaly had been reported [67]. Suspecting the causal link between Zika and microcephaly, the World

Health Organization (WHO) declared a public health emergency of international concern [71]. Zika virus was declared a "pandemic," which is an epidemic that is occurring worldwide or across a very large area, affecting a large number of people. Further, on June 5 2017, the U.S. Centers for Disease Control and Prevention (CDC) announced that "There is now scientific consensus that Zika virus infection during pregnancy is a cause of microcephaly [12];" the link between Zika virus and a catastrophic birth defect had been confirmed.

In contrast to previously studied crises such as geophysical, hydrological, meteorological, climatological, and political crises, the Zika pandemic is a biological epidemic crisis [2], a type of crisis induced by a disease. Epidemic crises have distinct characteristics: they are often accompanied by tremendous amounts of ambiguity in public knowledge of a disease's nature, origin, transmission pathways, symptoms, risks, and preventative strategies, as well as the geographical reach of a disease [25]. High scientific uncertainty leads to extreme uncertainty at the organizational level, since managing epidemic crises usually requires collaboration among public health agencies operating at different scales (local, regional, national, international) and different locations as well as coordination with individual healthcare providers working directly with patients [29]. Zika presents a particularly complex and politicized epidemic crisis because the disease causes microcephaly, thus touches on the sensitive issues of abortion and birth control. Both scientific uncertainty and the sensitive nature of this topic render Zika virus a hotbed for conspiracy theories.

2 RELATED WORK

In this section, we first describe collective sensemaking as the analytical framework of this research. We then introduce existing literature on rumor theory and rumor talk on social media during crises. Finally, we discuss HCI work on conspiracy theories on social media and provide an overview of studies of conspiracy theories related to public health research.

2.1 Collective Sensemaking

In this paper, we consider conspiracy theorizing talk on Reddit to be a form of collective sensemaking in which individuals work together to analyze and understand issues related to the Zika pandemic. Karl Weick defined sensemaking as "*placement of items into frameworks, comprehending, redressing surprise, constructing meaning, interacting in pursuit of mutual understanding, and patterning* [70]." Weick's notion of sensemaking has been adopted by the CSCW community to examine collective sensemaking on social media and in online communities. For example, Dailey and Starbird discussed collective sensemaking during a crisis, where people used Twitter to collectively identify, share, question, and discuss complex information related to the Deepwater Horizon oil spill [18].

We examine conspiracy talk and the emergent conspiracy theories about Zika as a process of collective sensemaking in which participants identify, share, question, and discuss Zika, forming lay theories about the genesis of Zika virus that are persistent despite the fact that they have no basis in scientific fact. Further, we see epidemic crises as creating a need for collective sensemaking. This sensemaking may be based on scientific information or it may be based on conspiracies, or some combination of the two. We examine the conditions under which collective sensemaking that is largely rooted in conspiracy theories takes hold.

2.2 Rumor and Rumoring on Social Media during Crises

Rumors on social media have drawn huge scholarly and media interest in recent years. Rumors have been studied from multiple perspectives, such as the link between rumors and individuals with interests [4], the instrumental value of rumoring in helping people make sense of and manage risk amidst situations characterized by ambiguity, danger, and threat [21], and as a form of collective sensemaking [5,53,66]. In the face of crisis, people face enormous uncertainty and have urgent information needs. In the absence of credible information, rumors serve as a means of collective sensemaking through which people cope with ambiguous situations [5,53].

To date, extensive research examines patterns of rumor transmission on social media [43,62] and the efforts on the part of the general public to correct rumors [6,69]. Less attention has been paid to the discursive mechanisms of generating and developing rumors, with a few exceptions. For instance, Bordia and DiFonzo developed a `general typology of 14 types of rumor-related statements [53]. Informed by this typology, Liao and Shi examined the categorization of rumor discourses related to a scandal on Weibo, China's largest microblogging site [42]. Another related research strand is the analysis of linguistic patterns in rumor-related social media posts [63,73]. Zhao et al. [73], for instance, proposed specific language patterns (e.g., verification questions such as "is this true" and corrections such as "rumor…debunk") that can be used for rumor detection. Starbird et al. [63] examined the use of linguistic shields and verbal milling rumor-related tweets during two crisis events; these are techniques used to express uncertainty in rumor-related tweets. Clearly a rich body of work related to rumors on social media is developing in HCI/CSCW. Our research both contributes to this line of work and extends it by focusing explicitly on conspiracy theories, a distinct subtype of rumors, described next.

2.3 Conspiracy Theory on Social Media

Compared to other types of rumor, conspiracy theories are distinctive in their long-lasting propagation period [45,63] and possession of a set of defining characteristics including having a small group that acts in secret with malicious purpose. Conspiracy theorizing is a complicated epistemological phenomenon that has existed throughout human history [38]. Despite the widespread existence of conspiracy theories, scholars have proposed multiple and sometimes conflicting conceptualizations of conspiracy theories and the conditions and causes of their genesis and spread. On the one hand, Richard Hofstadter famously used the term "paranoid style" to describe the pathological mindset and rhetorical style of conspiracy theorizing [31]. Some scholars consider belief in conspiracy theories irrational, foolish, and illogical [46], and express strong disdain for studying conspiracy theorizing at all [16]. On the other hand, some scholars have argued that conspiracy theorists often display a high degree of rationality [17,48]. Conspiracy theories often reveal deeper understanding of values and norms in a critical and cultural sense [15], are connected to popular cultural products such as novels and films—revealing conspiracy theories' social, cultural, and historical roots [51]—and are related to power disparities between individuals and institutions, revealing conspiracy theorists' deeply entrenched fear and resistance against the arrangements of the *status quo* [7,28]. In situations where authorities purposely withhold information from the public, people are more prone to collectively generate alternative narratives [65].

The Internet has fundamentally altered the creation and advancement of conspiracy theories by presenting a huge amount of available evidence and opinions, blurring the boundaries between authoritative and alternative information sources, and weakening the perceived legitimacy of various claims [58]. Conspiracy theorizing on the Internet presents in unique ways. Conspiracy theorists on Facebook tend to be self-contained and focus around specific topics, which leads to polarization of mainstream news consumers and conspiracy news consumers on Facebook [10]. Recent work by Starbird et al. [63] showed that a conspiracy theory peaked multiple times on Twitter while normal rumors tended to peak once and recede. Studies suggest that at least some conspiracy theories are very persistent. Rather than fading, they become more elaborate over time [45]. Nied et al.'s examination of "alternative narratives" countering the mainstream narrative on Twitter indicated that conspiracy theorists were not a singular, centralized group, but a wide network of groups of individuals with vastly different ideologies and political beliefs [50].

2.4 Conspiracy Theories related to Health and Disease

Conspiracy theories present enormous challenges to public health practitioners and policymakers, and have been a focus for public health research for several decades. A number of conspiracy theories about health and disease have been identified, i.e. that the FDA prevents the public from getting natural cures for cancer because of pressure from drug companies and that the global dissemination of GMO seeds by Monsanto is part of a program –"Agenda 21"—funded by the Ford and Rockefeller Foundations to control the world's population [9].

Research on such conspiracy theories has examined their genesis and consequences. Much research, for example, has examined a conspiracy theory that HIV/AIDS was developed by the government to attack certain segments of the population, showing how this conspiracy theory impedes prevention efforts [34]. Conspiracy theories can also prevent patients from receiving proper treatments [34] and impede efforts to contain public health crises [49]. Past research has found that populations are more likely to believe in specific conspiracy theories [37]. While there may be many reasons for this, one clear cause is that vulnerable groups often have higher levels of distrust in the public health and healthcare systems [1].

A body of research in the health domain has attended to *pseudoscience*, a term that refers to making science-like claims that nonetheless lack supporting evidence and plausibility [11,59]. Pseudoscience and conspiracy theory often intertwine, with one fueling the other. For instance, conspiratorial belief propelled people to deny AIDS by making claims such as governments creating AIDS for the purpose of genocide [34], while pseudoscientific claims, which for example attributed microcephaly to side effects of existing vaccines, might drive people to develop conspiracy theories to explain the origin of Zika virus [23]. While this line of work is valuable, the present research focuses explicitly on conspiracy theories related to health and disease. Our research contributes deep understanding of the production and development of conspiracy theories on social media, a topic about which little research exists.

3 METHODS

In this paper, we focus on Reddit as our study site of conspiracy talk. Reddit is an American news sharing and discussion website, ranked the 4th most visited website in the U.S. and the 15th worldwide [3]. In the next subsections, we describe Reddit's structural characteristics that are highly relevant to the organization of conspiracy theorizing talk, and introduce data collection and analysis methods.

3.1 Structural Characteristics of Reddit and Discourses

Reddit is a social news site that "allows viewers to rely on crowd participation to filter out the full collection of messages to surface important or relevant information" [41]. A 2016 PEW Research study reported that while 4% of U.S. adults used Reddit, 70% of these users got news on the site [8]. Reddit allows various communities to aggregate information and report news in various ways, ranging from redirecting the audience to external news sites to actively curating content from local sources [40].

To date, Reddit supports 1,103,232 subreddits curated around particular topics [55]. A subreddit is a distinct message board where people can view threads and start new threads with a user account. A thread has two forms: links or text post. Reddit users can comment on a thread. Reddit's commenting system is visually hierarchical "…where child comments of parent comments are tabbed to the right to visually depict the hierarchical relationship" [41].

Reddit uses a voting system where every user can vote up or down a post or a comment once. Reddit calculates a score based on the number of upvotes and downvotes, and uses it to rank threads within a subreddit and comments within a thread. The actual score is moderated by anti-spam algorithms [56]. Reddit provides various ranking systems for users to filter threads, such as "top" meaning "the highest-voted submissions to the top of the page" [41], "hot" meaning the highest-voted submissions to the top of the page with time in consideration [41], "new" which ranks submissions based on time, "rising," meaning submissions that receive many votes and comments in a period of time, and "controversial," referring to submissions that receive many upvotes and downvotes [22].

The Reddit interface supports the core cultural value of Reddit, which is to support users *to locate and share content* [52]. Drawing from Potts and Harrison's analysis of the Reddit interface [52], we examine an example of the Reddit interface in Figure 1. The visual arrangement of posts and comments is hierarchical so that readers can read them from top to bottom. Users can easily navigate through the post by expanding or collapsing comment threads. In addition, Potts and Harrison noted that, Reddit allows users to add links to their discussion, empowering users "to use memory as a device for linking to relevant material" [52].

Figure 1. The interface of Reddit.

3.2 Data Collection

On January 30th, 2017, roughly one year after the 2016 Zika outbreak, we used the search functions on Reddit to find Zika-related threads and subreddits. We identified five subreddits (/r/Zika_virus, /r/Zika_English, /r/zika_sp, /r/Zika_pt, and /r/Zika_fr) that directly address Zika-related topics. However, all these subreddits were largely inactive, judging by the number of subscribers and the number of comments per thread. In sharp contrast, we found that Zika attracted heated discussions across multiple subreddits not directly related to Zika, such as /r/news and /r/politics. This initial observation echoed political communication scholar Andrew Chadwick's idea that while "…high ideals of deliberative public sphere" are difficult to fulfil, online conversations emerging in general online spaces are of real value and worth close examination [14]. Presuming that much conspiracy talk existed in comments, because Reddit posts were designed in favor of sharing links to external news, we decided to focus on the top commented threads on Reddit, not focusing on any specific subreddit.

To collect Zika-related threaded conversations on Reddit, we used an open-source data crawling tool [20]. We used "Zika" as the sole search keyword, because the word unambiguously refers to the virus and has no alternative names. The Reddit API provided five filter criteria (top, new, comments, relevance, and hot). On January 30th, 2017, we used each of the five criteria to retrieve 1000 Zika-related Reddit threads, and combined them into 1,486 unique posts associated with 74,087 comments. We used MySQL to store all the posts and their associated comments, as well as metadata including time of creation, author name, subreddit, score, and number of comments (for posts only). The threads spanned over 346 subreddits following a long-tailed distribution, with 44% of threads in the top 10 subreddits. The posts received diverse scores (max= 32,770, min= 0, avg= 399.7, sd= 2097.8). Readers of a post can *upvote* the post, which results in the post score increasing by 1. Post score is viewed as a form of social reputation on Reddit [27]. The posts in our sample varied widely in the number of associated comments (max= 2,718, min= 1, avg= 49.9, sd= 178.6). The comments also have diverse scores (the number of upvotes minus the number of downvotes) (max= 6,969, min= -292, avg= 12.1, sd= 89.6).

3.3 Data Analysis

Among the 1,486 Reddit posts, we first selected 100 top-commented posts across all the subreddits. To ensure that our selection of Reddit discussion represented a diverse set of subreddits, we then selected the first 10 top-commented threads from the 10 most popular subreddits in terms of having posts related to Zika. The final dataset contains a total of 156 posts and 47,551 comments. We used content analysis [39] through to analyze our Reddit dataset.

3.3.1 Identifying Conspiracy Theories. Prior to answering the three research questions, we needed to first identify instances of conspiracy talk within the dataset. In threaded conversations, an instance of conspiracy talk was one that included a statement, a question, or an answer that directly invoked a conspiracy theory, as well as all the subsequent comments related to the conspiracy narrative. To locate instances of conspiracy talk, we first had to establish inclusion/exclusion criteria for identifying conspiracy theories and differentiating them from other types of rumors or misinformation. Towards this end, the first author surveyed literature on conspiracy theory using multiple academic databases and search engines such as Google Scholar, ACM Digital library, PubMed, and Springer. The first author also read broadly on existing popular conspiracy theories surrounding numerous events (e.g., the JFK assassination, moon landing, etc.) to develop an understanding of conspiracy theories.

Through discussions, the first two authors created the operational definition of a conspiracy theory containing the three criteria described in the Introduction section. Relating these criteria to our specific case, a conspiracy theory should provide an explanation regarding an aspect of the Zika crisis. The narrative should involve a small group operating in secret with malicious purpose. When executing these criteria to look for conspiracy theories, we deemed that the complete narrative of a conspiracy theory contains four elements: 1) *who are the conspirators*, 2) *what malicious purposes do they have*, 3) *what secretive actions do they do*, and 4) *how they take these secretive actions*. We then established the following workflow to identify instances of conspiracy talk (see Figure 2): First, if a comment contained all the four elements, we considered this comment together with is subsequent comments as a *confirmed* instance of conspiracy talk. If a comment contained at least one of the four elements, we marked this comment as a potential starting point for conspiracy talk, and continued reading its subsequent comments. If its subsequent comments contained other elements, we also marked the comment as a *confirmed* instance of conspiracy talk. If a comment had no element, we kept reading its subsequent comments. After this round of screening, we established a *confirmed set of instances of conspiracy talk*, but also a list of comments that had been marked as "potential starting point." This list of comments had two possibilities: first, a comment might be an underdeveloped instance of conspiracy talk if it had not received enough comments to collectively build up a conspiracy theory; second, a comment may not have been conspiracy talk at all. We used one inclusion/exclusion criterion to distinguish these two possibilities: If the elements mentioned by a comment and its subsequent comments matched a conspiracy theory from the basic set of instances that we had found, the comment and its subsequent comments were considered an instance, but underdeveloped. If not, the comment and its subsequent comments were excluded.

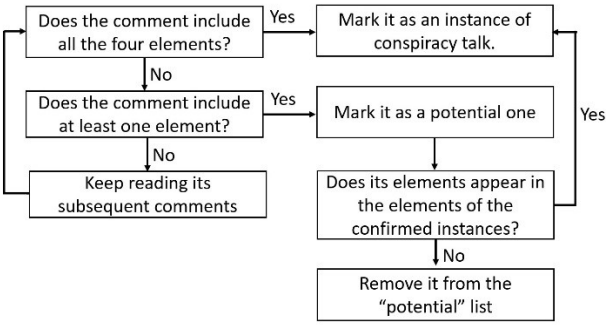

Figure 2. Identifying conspiracy talk workflow.

With these criteria and the workflow in mind, the first two authors randomly selected and independently coded 20 threads. At the thread level, the two authors' agreement was good (Cohen's Kappa coefficient κ = 0.66). The two authors discussed these threads one by one in detail to resolve disagreements. After this, the two coders independently coded the remaining136 threads. Eventually, we identified 119 instances of conspiracy talk. These instances belonged to 70 threads with 34,020 comments, indicating a substantial presence of conspiracy talk within the 156 threads. These instances contained 6,116 comments (number of comments per instance: min = 1, max = 818, median =9, average = 51.39). In our calculation, an instance had at least one comment. Therefore, the minimum number of comments per instance is 1.

3.3.2 RQ1: What were the conspiracy theories? The first two authors first read the 119 instances to develop an initial impression of the proposed conspiracy theories. Through discussion, they agreed that these conspiracy theories concerned several aspects of the Zika crisis. Because the sample size was small, the two coders independently coded all the instances. The two coders then discussed their respective codes and identified and aligned similar concepts. At this point, their agreement was good (κ = 0.61). They then discussed all the instances one by one together to reach full agreement (κ = 1). Eventually, the two authors coded all the 119 instances into eight categories: Zika origin, link between Zika and microcephaly, authority actions, legislation, Olympics, mainstream media, research on Zika, and religion. Table 1 shows descriptive statistics about the number of comments per instance across these eight categories.

Table 1. # of Comments per Instance in Each Category (C1 = Zika origin, C2 = link between Zika and microcephaly, C3= authority actions, C4=legislation, C5=Olympics, C6=mainstream media, C7=research on Zika, C8=religion).

Category	Range	Median	Average	Total
C1	[1, 792]	8	79.07	2135
C2	[2, 587]	37.5	72.5	1450
C3	[1, 121]	4.5	21.64	476
C4	[3, 35]	8.5	13.88	111
C5	[1, 818]	55.5	115.71	1620
C6	[1, 66]	4.5	12.22	220
C7	[1, 10]	2	4.33	13
C8	[1, 43]	4	13	91

3.3.3 RQ2: Under what conditions were conspiracy theories proposed? To answer this question, we needed to consider the discursive context in which an instance of conspiracy talk existed, including all the prior discourses that took place before people brought up a conspiracy theory. The first two authors read the 70 threads to obtain an initial sense of the discursive context in which conspiracy explanations emerged. Again, two coders independently coded all instances independently with good agreement (κ = 0.72). Eventually, we identified four conditions under which people proposed conspiracy theories: distrusting the mainstream news (37.81%), finger-pointing at individuals or groups (28.57%), sharing conspiracy theories to initiate discussion (27.73%), and making conspiracy theories for entertainment purposes (5.88%).

3.3.4 RQ3: What were the discursive strategies to construct and develop conspiracy theories? To answer the last question regarding the discursive strategies that conspiracy theorists used to construct and develop conspiracy theories, the two coders followed a semi-open coding procedure. We adopted the seven rhetorical strategies reported by Meylakhs et al. [47]: scientific argument, ideological argument, underscoring personal experience and critical thinking, underlining material interest of the powerful, pointing out suspicious practices of authorities, claiming uselessness and toxicity of authoritative measures, and use of unconnected statements from legitimate sources. We consider this work's proposed strategies as a source of inspiration because some of these strategies were reported to be used to develop conspiracy

theories related to explaining AIDS. When coding each comment, we first checked to see if it matched one of Meylakh's rhetorical strategies. If not, we developed a new code for the statement. We randomly selected 200 comments and coded independently. We then discussed each comment one by one to establish a codebook containing 16 codes (12 discursive strategies and one "other" category denoting statements that do not serve to develop a conspiracy theory, such as opposing a conspiracy theory). After this, we again selected another random set of 200 comments to code independently, with satisfactory agreement ($\kappa = 0.73$). The two coders then divided the remaining 5,597 comments to code respectively. Eventually, we identified 3,522 comments to construct and develop conspiracy theories. The percentages of the discursive strategies are: citing authoritative information selectively (14.05%), citing popular cultural products (4.03%), elaborating (18.48%), connecting the dots (8.57%), imagining a scenario (3.27%), meta-discussion of science (4.68%), ideological argument (13.63%), proposing unknowable risks (7.01%), casting doubts (10.16%), meta-discussion of conspiracy theory (12.24%), critical thinking (1.62%), and deflecting the burden of proof (2.24%).

When reporting data, we use pseudonyms (e.g., u1, u2, u3) to represent Reddit users in conversation.

4 FINDINGS

Next, we discuss what the conspiracy theories were, under what conditions they were proposed, and what discursive strategies were used to develop these conspiracy theories.

4.1 What were the Conspiracy Theories?

The Zika crisis has triggered conspiracy talk about a wide range of issues related to the Zika pandemic. The imagined conspirators included wealthy people, the U.S. federal and state governments, terrorists, scientists, big agriculture companies, big pharmaceutical companies, the International Olympic Committee (IOC), mainstream media, and politicians. Surprisingly, we did not find any instances where the CDC or the WHO were targeted by conspiracy talk. While this small-scale study is by no means conclusive, this observation echoes a 2015 Pew Research Center survey of 1,504 American adults, in which the CDC had the most favorable reputation among all federal agencies [13]. While the imagined conspirators were many, the identified "malicious purposes" were relatively few. Population reduction, terrorist attack, corporate actors' commercial agendas, and corruption were the primary malicious purposes discussed.

In Table 1 we categorized all identified Zika conspiracy theories into 8 themes and 10 narratives. We also counted the frequency for each narrative. Theme 1 and 2 contained four narratives and revolved around distrust in known scientific knowledge of Zika virus. The three "Zika origin" narratives in theme 1 sought to explain that Zika did not come from nature as described in scientific findings, but was designed in laboratories for *terrorist purposes* or *population control*. Neither of these malicious purposes are novel and both have roots in contemporary culture. The former has become a major challenge to modern societies, while the latter has already been discussed on mainstream media [26]. The "link between Zika and microcephaly" in theme 2 claimed that Zika was a cover-up and pesticides and chemicals were the real cause of microcephaly, propagated by big agriculture companies such as Monsanto. Notably, Zika conspiracy theories did not necessarily agree with each other. For example, the "Zika origin" narratives posited that Zika was dangerous and powerful enough to reduce the human population. However, the "link between Zika and microcephaly" theory denied the effects of Zika infection in order to blame big agriculture companies.

Themes 3-5 concerned the decisions and status of authorities, including local and federal governments in the United States, the U.S. congress, the International Olympic Committee and the Brazilian government. These narratives contained strong mistrust of certain governments and organizations, asserting that corruption was the primary and only explanation for any actions taken by authorities and the primary motivator of official decision making processes around handling of Zika. In these narratives, the conspirator was no longer a single group, but the alliance of several powerful groups such as governmental agencies and corporate groups. In the "authority actions" narrative, governments had dubious connections and conflicts of interest with companies contracted to control mosquitos. In the "legislation" narrative, people claimed to

see the connection between congress and big pharmaceutical companies. In the "Olympics" theory, the IOC, the Brazilian government and Brazilian local companies were imagined to have a secret relationship involving bribery.

Table 2. Conspiracy Theories generated on Reddit related to the Zika outbreak.

Themes	Conspiracy theories	Examples
1. Zika origin (22.7%)	The wealthy people hired scientists to design and release Zika in order to control population (11.8%).	"A big part of the globalist conspiracy is depopulation. TLDR: Rockafellas, Recently released genetically modified mosquitoes & population control."
	The government released Zika for population control (8.4%).	"Has anyone made a... "Zika Virus isnt real its a government conspiracy to control the population" joke yet?"
	Terrorists released Zika (2.5%).	"Wait for ISIS revendication."
2. Link between Zika and microcephaly	Microcephaly was not caused by Zika, but by pesticides and chemicals produced by big agriculture companies (16.8%).	"Zika exists but is being used as a scapegoat because these birth defects are really being caused by fertilizers and pesticides and everyone has been bought off by Big Agriculture."
3. Authority actions	Government was corrupted and its actions to counter Zika were dubious (18.5%).	"They knew there would be massive collateral damage, however, they probably set up a deal between the state and some poison manufacturer to make themselves a nice paycheck while pandering to the fears of the masses"
4. Legislation	The congress was corrupted and did not pass any Zika-related bills and big pharmaceutical companies would profit (6.7%).	"I'm very happy they are blocking it. It's just another money laundering exercise to Big Pharm."
5. Olympics	The International Olympic Committee (IOC) would neither remove nor cancel Olympics for Zika because they bribed/received bribery from Brazil (11.8%).	"The IOC is probably just ordering mass quantities of mosquito repellent they can sell at a 20,000% markup. While bribing the Brazilian government to make all other mosquito repellents illegal for the duration of the Olympics, no doubt."
6. Mainstream media	The media is exaggerating the severity of Zika (15.1%).	"Zika is not a big deal. Just another media driven scare."
7. Research on Zika	Scientist received bribery from big corporations (2.5%).	"The studies have not confirmed without a doubt Zika causes birth defects and many scientists have been bought off before by big corporations."
8. Religion	Politicians use Zika to manipulate religious individuals or groups (5.9%).	"It is a political gotcha thing...This Zika Virus is a medical thing that they need to cure and prevent, it just happens to cause birth defects. Because of that the political people want the church to change their position on abortion and birth control."

Topic 6 concerns the integrity of mainstream media, as media was imagined to exaggerate the severity of Zika in cooperation with other companies or their own agenda. Moreover, when people accused mainstream

media, they often mentioned conspiracy theories related to previous health crises such as H1N1 and Ebola, claiming that these crises were merely a hoax.

Topics 7 and 8 concerned how powerful groups (politicians and big corporations) coerced and manipulated less powerful groups (scientists and churches) to the former's advantage. In this theory, big corporations bought off scientists, and the churches were forced to cooperate with politicians in choosing a stance.

4.2 Under What Conditions were Conspiracy Theories Proposed?

We next describe the discursive contexts within which people brought up conspiracy theories. We found four primary ways people proposed a conspiracy theory in the specific context of a Reddit thread or comments. They are *challenging the mainstream news*, *finger-pointing at individuals or groups*, *asking for more clarification on conspiracy theories*, and *conspiracy theorizing for entertainment*. Below we describe each pattern in detail.

4.2.1 Distrusting Mainstream News. The most frequent antecedent for Reddit users proposing conspiracy theories was an experience of dissatisfaction with the mainstream news shared by the original Reddit post. Responders thus started proposing conspiracy theories to challenge mainstream information about Zika. Responders challenged mainstream news in two ways: casting doubts about the validity of mainstream information and the accountability of mainstream media, or proposing alternate theories to counter mainstream information.

The most common way in which Reddit posters challenged mainstream news was casting doubt about the validity and accountability of mainstream media, regardless of the actual content of the news article. Here is an example:

> ***Post:*** *Zika virus: Outbreak 'likely to spread across Americas' says WHO - The infection has already been found in 21 countries in the Caribbean, North & South America. (source: bbc.com)*
> ***U1:*** *i dont believe in Zika, this is fake and pure propoganda designed to scare people into buying useless medicine.*

In this example, U1's comment did not directly address the actual news content in any way, but instead suggested the "media hype" conspiracy theory, meaning that media always exaggerate the severity of news to increase its publicity, one that was commonly reported in previous literature [36,49,54].

People also proposed conspiracy theories to directly counter the narratives presented in mainstream news:

> ***Post****: More than 5,000 pregnant women in Colombia have Zika virus, 31,555 total infections, country's national health institute says (source: reuters.com)*
> ***U2****: This is total fear mongering horse shit. There's no reliable test for zika virus, so these are just assumptions... But during the hysteria, every single case was swine flu. Zika probably isn't causing microencephaly, and these numbers are 100% fear mongering horse shit just like the rest of these mass health scare viruses all turned out to be.*

In this example, U2 not only adopted the media hype narrative, but also made many direct, detailed counterarguments to support the narrative.

4.2.2 Finger-Pointing at Individuals or Group. That people *often* mistrusted mainstream news did not mean that people *always* doubted the credibility of information from mainstream media. On the contrary, Reddit users seemed to show trust and a general proclivity towards news articles reporting failures of powerful individuals or groups. By finger-pointing, we mean that conspiracy theorists tended to put enormous emphasis on the individuals or groups, claiming that the latter's conspiracies caused such negative consequences. They developed conspiracy theories that directly pointed to these individuals' or groups' secretive agenda. Here is an example where people pinpointed specific individuals:

> ***Partial content of the shared news in a Post****: Gov. Rick Scott released the following statement Tuesday after the vote: "... I am disappointed a bill which included funding for the Zika virus died today in the Senate. The Zika virus is a national issue and demands immediate federal action. I hope Congress and the President quickly agree on funding to combat Zika so we can protect pregnant women and their growing babies who are most harmed by this virus."*

***U1**: As I could not find it anywhere in the article (and is blocked by the WPTV5 info-bar in the video): Here is a link to the bill in question, H.R.2577. Here is a link to the vote in question. In the event one wishes for more details.*
***U2**: Also worth noting that Scott's wife owns a multi-million dollar stake in a mosquito control company.*
***U3**: And she was an owner of the company that was doing drug testing on welfare recipients? Damn, I'm a Chicagoan and that's some shady, corrupt shit.*

In this example, the mainstream news was about the congress blocking a Zika-related bill and Governor Rick Scott expressing his disappointment in congress' action. While not countering the news, U2 and U3 believed Rick Scott's true intention was to benefit his wife's business. U2 and U3's statements served to build an "authority action" conspiracy theory around how politicians and corporations worked together to benefit from Zika and maximize their profit gain. Another instance of finger-pointing was aimed at a state government rather than a single individual:

***Post**: 'Like it's been nuked': Millions of bees dead after South Carolina sprays for Zika mosquitoes. (source: washingtonpost.com)*
***U4**: "We are concerned about protecting the health of our citizens... That is why we dumped a fuckload of poison everywhere." Conspiracy Theory: They knew there would be massive collateral damage, however, they probably set up a deal between the state and some poison manufacturer to make themselves a nice paycheck while pandering to the fears of the masses.*

The news article reported how South Carolina's mosquito control spray killed millions of bees. U4 did not question the news. Instead, U4 built up on the news to produce a conspiracy theory of the secret deal between the state and an unnamed poison manufacturer.

Interestingly, U4 indicated clearly that the narrative was a conspiracy theory. Naming a conspiracy theory as such while theorizing is a linguistic strategy is to express uncertainty according to Starbird et al. [63]. Another common linguistic strategy employed during theorizing is "*my conspiracy buff friend told me*," which serves to deflect responsibility for the information away from the individual engaging in conspiracy talk. Like U4, many conspirators in this discussion were aware that they were talking about conspiracy theories by explicitly using the terms "conspiracy theory," "conspiracy theorist," or just "conspiracy" to describe their discourse and/or themselves. They nonetheless continued their conversations, rejecting the idea that conspirators were paranoid people without rationality or awareness of their own mental conditions.

4.2.3 Sharing Conspiracy Theories to Initiate Discussion. While the previous two scenarios took place as people directly brought up conspiracy theories in response to the shared news in a post, people also proposed conspiracy theories to generate further discussion. Such comments provoked conversation with others, as was intended by their authors. For example:

***Post**: Microcephaly cases in Brazil predate Zika virus outbreak, study says (source: cbc.ca)*
***U1**: I've been seeing the "Microcephaly not caused by Zika but by Monsanto" angle on a lot of greeny / conspiracy websites. Does anyone know if the source for this story is reputable?*
***U2**: Apparently some scientists suggested that it may be insecticide chemical. The anti-Monsanto people started spinning that like crazy. There is currently no confirmed link between the two.*
***U3**: Or Brazil is the only country in the area that has the lax standards to use the insecticide improperly and the need for it.*

In this instance, U1 mentioned a conspiracy theory but also expressed uncertainty in the credibility of a specific conspiracy theory by asking an open question. This strategy for initiating discussion resonates with the notion of 'milling behavior,' which means that people raise an open question in order to build or shift a rumor story [63]. In this conversation, proposing a conspiracy theory was used to seek verification and initiate a conversation that gathered information around the possible connection between insecticide and microcephaly. U2 and U3 did not directly confirm or deny the conspiracy theory, but provided more information into the conversation. U2 first cited findings from some scientists to admit the possibility of the conspiracy theory. But U2 also pointed out that people who disliked Monsanto might be overreacting to the scientific findings. U3 pointed out why the misuse of insecticide could happen in Brazil.

4.2.4 Making Conspiracy Theories for Entertainment Purpose. In previous cases, our data suggest that people consciously considered conspiracy talk a legitimate form of discussion, regardless of the specter of social stigma. But we also observed that people constructed conspiracy theories in playful, non-serious ways.

***Post**: Zika crisis: Rio Olympics 'should be moved or postponed'. (source: bbc.com)*
***U1**: Zika is the last of an enormous list of reasons to cancel or move this years Olympic games.*
***U2**: But the bribes have already been paid and spent!!*
***U3**: The services have already been rendered.*
***U4**: The past is written. The ink is dry.*
***U5**: burn the paper.*
***U6**: hold the door*

In this instance, five people collectively completed a quasi-parallel structure to enrich the elements of a conspiracy theory. The lines were adopted from *Game of Thrones*, a popular American television series, suggesting a playful context for conspiracy talk. The conversation nonetheless pictured a conspiracy theory where bribes had an influence over the Olympics.

In another instance, a person brought up a conspiracy theory with a playful, non-serious tone that nonetheless meets all of the criteria for a conspiracy theory:

***Post**: UN Demands Zika-Infected Countries Give Women Access To Abortion And Birth Control*
***U1**: Has anyone made a... "Zika Virus isnt real its a government conspiracy to control the population" joke yet?*
***U2**: I wish people were only joking but a majority of my Facebook friends are pretty serious about it. They even go as far as blaming vaccines for it :'") EDIT: I deleted about 50 people from Facebook and BTW, those were all people I know IRL. I think I need new friends.....:')*
***U3**: I always get downvoted for explaining why people think things are a conspiracy but here I go anyway.*
http://www.oxitec.com/press-release-oxitec-mosquito-works-to-control-aedes-aegypti-in-dengue-hotspo/ Genetically modified mosquitos being released in mass @ Zika ground zero. Also the Rockefella foundation discovered it in the 1940's it has since mutated. Anything the Rockefella's touch is going to bring out conspiracy theorists. Those two facts combined with the effect that this virus will have on birth rates overall. A big part of the globalist conspiracy is depopulation. TLDR: Rockafellas, Recently released genetically modified mosquitoes & population control.
***U4**: Creating a disease that makes babies retarded but lets them live is sort of an indirect route to depopulation, especially if the evil masterminds behind it had 70+ years to think about it...*

In this example, U1 clearly indicated that a conspiracy theory was a "joke" in a playful, casual tone, perhaps just to entertain themselves in a discussion with other Reddit users. U2 agreed with U1's judgment of the conspiracy theory as a ridiculous claim. However, U3 and U4 expressed different opinions and provided evidence to support the conspiracy theory. This example shows that even seemingly playful theorizing can develop into more serious conspiracy talk.

4.3 Discursive Strategies to Construct and Develop Conspiracy Theories

In the 119 instances of conspiracy theory identified in the dataset, we found that a majority of statements that made in response to conspiracy talk served to strengthen a conspiracy theory. We also found instances of utterances made to weaken conspiracy theories. In this paper, we focus primarily on statements of the former type. We identified 12 strategies, which were categorized into three functional groups: strengthening conspiracy theory, weakening the reputation of authorities, and defending conspiracy theory.

4.3.1 Strengthening Conspiracy Theory. The main function of this group of strategies is to construct a more elaborate and robust conspiracy theory with a focus on improving the logic of the whole narrative, as well as adding more information to the theorizing discourse.

Citing authoritative information selectively uses academic, mainstream media, or government information sources to selectively back up conspiracy viewpoints: U1: *Zika is not the real cause of these birth defects in the first place, from what I've heard about it in South America, they are from pollution and chemicals such as Round Up...thanks Monsanto!* U2: *Yep! One study, there are others. http://pubs.acs.org/doi/abs/10.1021/tx1001749*

Citing popular cultural products is a strategy in which theorists derive explanations from popular cultural products such as movies, television shows, or even viral videos: *U1: Sounds a lot like the plot of the movie Outbreak....U2: if you think that all discoveries of viruses in the wild are like Outbreak...*

Elaborating refers to complementing the existing conspiracy narrative with richer information (although the link between this information and Zika is often unverifiable): *U1: Just another fucking fear mongering campaign… the 'zika virus' is this year's 'ebola'. U2: And the purpose is? U3: well, it's a real issue… it makes money. people want to be scared, scary diseases, antibiotics, nuclear war, terrorism, whatever is convenient, the media will pander to us to make it as horrifying as possible so that we talk about it, listen to them, and give them advertising dollars... The purpose is attention…*

Connecting the dots is a strategy in which a conspiracy theorist pieces together bits of information that were previously unrelated: *The mosquitos were said to be there to reduce malaria but it is precisely where they were released that Zika virus began its current extensive spread. Again this was before zika was even in the news and before it had appeared. Long before. Now it seems to be a baby destroying virus which breeeds inside mens' testes. Just sayin'....* In this example, the conspiracy theorist pointed to the possible links between the location where genetically modified (GMO) mosquitoes were released to reduce malaria, and the location where Zika virus began to spread.

Imagining a scenario is a strategy to imagine and describe a realistic, detailed scenario of one part of a theory: U1: The IOC is probably just ordering mass quantities of mosquito repellent they can sell at a 20,000% markup. While bribing the Brazilian government to make all other mosquito repellents illegal for the duration of the Olympics, no doubt. U2: Zika Spray! Get your Zika spray! $50!

4.3.2 Weakening the Reputation of Authorities. The main function of this group of strategies is to dismantle governmental and scientific groups' authority in explaining Zika virus.

Meta-discussion of science seeks to weaken the authority of science: U1: I'm just a scientist who understands genetic modification. U2: Scientists fuck shit up all the time...every single day. A significant amount of scientific discovery has been by accident. In this example, people brought up conspiracy talk about the news that authorities used GMO mosquitoes to control Zika transmission. When U1 appeared as a scientist, assuming some authority in explaining GMO mosquitoes, U2 challenged U1.

Ideological argument is a strategy that builds conversations around criticism against the present political-economic system: U1: I feel like it's a fucking gong show in America, like nobody is in charge of anything except if it means doing greedy knee jerk stupid and corrupt shit. U2: You nailed American politics. U3: That's how I see it also, Americans democracy is held hostage by capitalism refusing to be reined in. U4: Succinct and accurate (and now plagiarized by me). U1 made the comment on a news article reporting a negative consequence of an authority action that intended to kill mosquitoes but also killed millions of bees.

Proposing unknowable risks is a strategy in which theorizers stress that an authority's actions might be unknowable but must be consequential: *U1: We really can't go on with this capitalist, profit-motive bullshit much longer… If anti mosquito sprays are accidentally killing bees, what else are they killing?*

Casting doubts is a strategy to throw doubt on the behavior of the imagined conspirators: Actually it is suspected that Zika is causing birth defects. Brazil says there is some sort of link between them, but the US says no because Brazil refuses to send any samples of the virus, so the CDC is left with samples from 2013.

4.3.3 Defending Conspiracy Theory. Meta-discussion of conspiracy theory is a strategy that seeks to legitimize a conspiracy theory by stressing the rational, reasonable part of conspiracy theories: *It's not always simply wild speculation… There are a lot of other topics discussed. Many insane, many worth merit.*

Critical thinking means that the theorist stressed being critical against mainstream narratives, often accusing the disbelievers of political naiveté: *U1: Just another fucking fear mongering campaign. Anybody ever wonder how the whole ebola scare just kinda went away? Yeah, that's what we have here, the 'zika virus' is this year's 'ebola'. U2: More than 10,000 died from the ebola outbreak... U1: Yeah, ok... Hey, you just keep believing whatever our corrupt main stream media tells you. Good luck with that*

Deflecting the burden of proof means the theorist pointed to others when disbelievers asked for proof: U1: Why don't you see if you can follow the money trail? These are public gov't works which can be accessible and the freedom of info act. Go digging and prove your theory. U2: Somebody who actually lives in the United States might be better equipped to pursue this theory than myself xD.

5 A CASE STUDY OF CONSPIRACY TALK

After presenting the four conditions under which conspiracy theories were proposed as well as the 12 discursive strategies to develop conspiracy theories, we closely examine a case study of conspiracy talk in Figure 3 (This example only contains 13 statements at the top of the instance. The whole instance of conspiracy talk contains 792 statements). The instance comes from one of the top-commented threads, with 2,314 total comments. We use colors to denote the different levels where a statement was made within the discourse on a Reddit thread.

In this example, Reddit users collectively discussed the theory that a lab privately owned by the Rockefeller family designed and released the Zika virus to deal with the human *overpopulation problem*. Seven discursive strategies identified in this study were used throughout the process. Notably, almost all the steps within this collective theorizing activity rendered the narrative more plausible. U1 first proposed a sketchy narrative about a lab designing Zika. When U2 raised question upon the lethality of Zika, U3 complemented the narrative by highlighting the *plausibility* that "it could take years" ("genetic points" refer to items in Plague Inc, a pandemic simulation mobile game.). Here U3 did not explore other possible options that might weaken the initial narrative. Another reply to U1 by U4 added more information (e.g., owned by Rockefeller). Here U4 also expressed *uncertainty* by starting with the phrase "my conspiracy buff friend told me," which Starbird et al. called an 'attribution shield' that "deflect(s) responsibility for the information onto an external source [63]." Such uncertainty indicates U4's weak confidence in the *accuracy* of this information. U5's elaboration of U4's claim, as well as U6's follow-up judgment included more unverifiable statements which the theorists attributed to the "obscurity" of evidence, again favoring plausibility rather than accuracy. U7 and U11 strengthened the narrative by pointing to more supporting evidence, highlighting the possibility that the conspiracy theory could be true and conspiracy theorizing is legitimate.

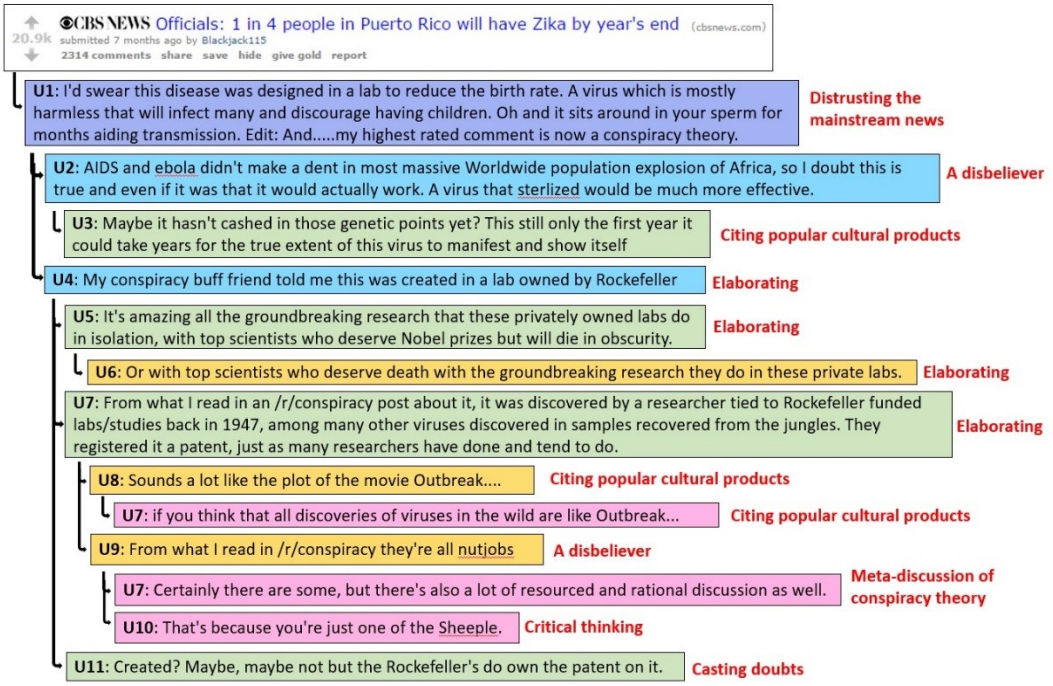

Figure 3. an annotated example of conspiracy talk (different color denotes conversation turns in the nested discussion structure. There were eleven unique users in this example, each with a unique pseudoname.)

The discursive process of theorizing about Zika virus was shaped by the particular structural characteristics of the Reddit interface [52]. The conspiracy talk was open to any user wanting to express an opinion or share information, as a person could make comments about a statement at any layer of the tree-structured discourse. In addition, Reddit users could easily move up or down to check in a particular conversation with another user to discuss one specific detail of a conspiracy narrative. For example, U7 actively defended the conspiracy theory by either confirming the value of popular cultural products in a conversation with U8, or refuting the attack towards conspiracy theory in a conversation with U9. Moreover, users could conveniently cut and paste links to refer to external sources in order to support their points, such as U7 referring to a specific subreddit '/r/conspiracy.' By supporting users to share and comment upon content, the Reddit interface played an indispensable role in the development of a robust conspiracy theory.

6 DISCUSSION

In this paper, we analyzed conspiracy talk on Reddit in response to the Zika-induced biological epidemic crisis. Notably, the conspiracy theories that were proposed on Reddit involved a broad range of issues, information, and authorities. In contrast to previous work that viewed the production of Zika-related conspiracy theories as intentional [33], we found that conspiracy theorists easily introduced conspiracy theory into Zika discourse on Reddit, perhaps simply because a particular piece of news or the flow of Reddit conversation triggered conspiracy thinking (this talking) or triggered recitation of conspiracy theories heard elsewhere. Talking about conspiracy theories is not necessarily shameful or fraught with social stigma, as some scholars have argued [46]. Rather, the social norm on Reddit can be described as having a low threshold for conspiracy talk—posters seemed to 'think out loud' and share conspiracy talk easily, whether intended for serious discussion or merely entertainment.

Based on our analysis, we developed a typology of discursive strategies for conspiracy theorizing on social media during a health crisis. Certain strategies relied heavily upon the interface design of Reddit, such as supporting the strategy of *elaborating* by allowing users to insert links to external websites. These strategies are also closely related to characteristics of public health crisis. Most notably, some strategies concern ordinary citizens developing seemingly scientific arguments, such as *citing authoritative information selectively*, *meta-discussion of science*, and *proposing unknowable risks*. The rationality and pursuit of scientific explanation within these discursive strategies indicates the need that ordinary citizens have to make sense of the Zika crisis. Starbird's analysis of Twitter detected "strong political agendas" underlying many conspiracy theories on Twitter around mass shooting events [60]. As our typology shows, *ideological arguments* are at play, focused upon attacking the *status quo*. However, this strategy was not dominant, perhaps because the present typology was derived from discourses about public health crisis.

We consider conspiracy theorizing, particularly talk that resulted in fully-developed conspiracy theories, as a process of collective sensemaking in which people identify ambiguity, share information, raise questions, and discuss possible explanations, forming lay theories about the genesis of Zika virus. Such theories are persistent and pervasive. Next, we will discuss the characteristics of this collective sensemaking process in the context of public health, the role of social media in this process, and implications for design.

6.1 Conspiracy Theorizing as a Form of Collective Sensemaking about Public Health Crises

Conspiracy theorists brought numerous items into their interpretive frameworks to explain what *really* happened in the Zika crisis. One cannot help but ask: if the information is not accurate, why do conspiracy theories persist in the face of factual information? Collective sensemaking literature points out that accuracy is not what drives sensemaking. Rather, it is "*…driven by plausibility rather than accuracy.*" Weick elaborated on this point: "*If accuracy is nice but not necessary in sensemaking, then what is necessary?...In short, what is necessary in sensemaking is a good story* [70]." Conspiracy theories are memorable, capturing both thoughts and feelings, as well as adaptable, capturing important aspects of past experiences (such as cultural legacies of mistrust of certain entities). They present a "good story" that is easily transmittable over time. Contrary to both popular belief and research depicting conspiracy theories as irrational, illogical, and stupid [46], our research

reveals that Reddit users gathered information, expressed doubt, constructed links, and performed logical reasoning.

Conspiracy theorists often valued plausible information that supported their narrative. They also cited authoritative information selectively to support a conspiracy theory. When authoritative information such as the mainstream news was undesirable, Reddit conspiracy theorists attacked it. This strategy resonated with how theorists on Twitter appropriated mainstream and alternative news [60]. Compared to plausible information, accurate, scientific information with sufficient supporting evidence was scarce. The scarcity of scientific knowledge can induce high scientific uncertainty in crisis events [29,61]. For example, the WHO and CDC took years to confirm that Zika virus was a cause of microcephaly [12]. Before the confirmation when people faced extreme uncertainty in the link between Zika and microcephaly, as well as other important scientific issues, conspiracy theories were comprehensive in covering all the issues and providing a plausible explanation, thus reducing people's anxiety [66]. High scientific uncertainty thus at least partially fueled the form that collective sensemaking took.

In addition to scientific uncertainty, we also observed high institutional uncertainty. Pandemics affect multiple countries and regions and require coordination between institutions at local, national, and international levels. However, in our study conspiracy theorists noticed disconnection between the multiple countries, agencies, and organizations involved in the Zika crisis, leading to suspicions of inappropriate secrecy among authoritative entities and resulting in the discursive strategy to weaken the reputation of authorities by *casting doubts*. It seems that the conspiracy theorists might interpret the lack of coordination in a hodgepodge network of public health organizations as "artful" deception. This echoes Dean's characterization of conspiracy theory as a response to the uncertainty that is created because of the multi-institutional system that is distant from the public [19].

In a public health crisis, both high scientific and institutional uncertainty could be long-lasting, compared to other natural or manmade crises. Therefore, plausible explanations, even if they lack supporting evidence and scientific rigor, seem not only desirable, but also irreplaceable. Crisis events are moments of disruption and uncertainty. Previous crisis informatics work describes how citizens used social media to cope with crisis and develop normalcy [44,57]. In this sense, conspiracy theorizing on social media during crises also helps people regain normalcy by drawing upon their previous, normal experience and knowledge to explain crisis situations.

Conspiracy theorizing as a form of collective sensemaking on Reddit is sometimes improvisational, in the sense that a large number of unrelated strangers draw on many other sources of inspiration to make up a plot, characters, narratives, and motivations on the fly. This is most evident in conspiracy theorizing for entertainment, where several distinct Reddit users contributed to constructing a novel conspiracy theory. This collective act appeared to be fun, but could also have potentially dangerous consequences as other individuals or media organizations may misinterpret the conspiracy theory if they encounter the discourse without understanding the particular context of its creation.

Starbird warned that conspiracy theorizing's "crippled epistemology may be exacerbated by the false perception of having a seemingly diverse information diet that is instead drawn from a limited number of sources" [60]. Our typology agrees with this argument as many strategies selectively use available information. Through analyzing conspiracy theorizing through a collective sensemaking framework, we point to another shortcoming of conspiracy talk, which is the loss of individuality as people participate in proposing and developing conspiracy theories.

6.2 Role of Social Media in Health-related Conspiracy Theory

The production of Zika-related conspiracy theories has both commonalities and differences with previously studied conspiracy theories generated on social media during manmade crisis events such as the Boston Marathon Bombings [63] and mass shooting [60]. First, both draw inspiration from the existing culture of conspiracy theorizing. For example, before the Zika outbreak, there was already a long conspiracy theorizing tradition of linking any number of widespread diseases to a small group of wealthy actors who desire population reduction [24]. Similarly, the U.S. government has frequently been cast as the perpetrator of a wide variety of conspiracies for many years [37]. Second, people did not rely upon a single social media platform for

theorizing, which would have indicated the existence of an "alternative media ecosystem" [60]. Instead, we observed people citing information or a whole conspiracy narrative from other subreddits or external websites. Third, conspiracy theories all involve a group of people collaborating in the development of a seemingly sound interpretation of an ambiguous situation, whose buildup relies upon many discursive actions to bring in more evidence, smooth the storyline, and fix logical imperfections.

The most prominent difference we have noticed between conspiracy theorizing about Zika and other conspiracy theories (both health and non-health related) lies in the extreme scientific uncertainty in Zika virus. Within the eight categories we reported, scientific uncertainty directly led to the emergence of conspiracy theorizing of Zika origins and its link to microcephaly. Scientific uncertainty was coupled with little knowledge about the proper ways to contain Zika virus, which encouraged the growth of mistrust in the actions of authoritative organizations and legislation, another two categories of conspiracy theories. In contrast, political leanings and ideologies were an important factor in the theorizing of mass shooting events on Twitter [60].

The high uncertainty associated with Zika not only drove people to social media to look for essential information, such as local, hyperlocal, and alternative information [29], but also helped create and spread conspiracy theories. Such contradiction resides in the differences of social media sites and human behavior. In [29], people consciously targeted specialized social media, such as the Grand Cayman Travel Forum on TripAdvisor.com, to seek specific information about local conditions.

In this study, we found that Reddit as a social news site supported conspiracy theorizing activities. A thread sharing mainstream news could attract thousands of unique users making comments, guaranteeing that the proposition of a conspiratorial idea could reach and resonate with a sufficient number of people (critical mass) to participate in the collective theorizing process. Second, the nested discussion structure allows people to easily converse with others to elaborate on any detail of a conspiracy theory. Even when no one summarized the conspiracy theory into one full, rich narrative, the instance nonetheless existed as a social media artifact, remaining searchable and visible over time. It would be unsurprising if in a future public health crisis, people used these threads as an archive and drew inspirations for developing new conspiracy theories.

7 DESIGN IMPLICATIONS

Social media has great potential to strengthen public health information infrastructure, facilitating information dissemination and communication between public health agencies and the public. First, public health agencies might use social media to monitor the development of conspiracy theories on social media and intervene in conspiracy theorizing. Previous work shows that public health agencies actively posted Zika-related information on Twitter but their tweets' content did not necessarily match average citizens' general interest and concern [30]. Public health agencies can improve the effectiveness of their communication and interaction with the general public if they can quickly detect, monitor, and ananlyze emerging rumors and conspiracy theories during public health crises. Zhao et al. proposed methods for early detection of rumors based on linguistic patterns [73], a potentially fruitful design approach to help public health agencies detect conspiracy theories on social media. The discursive strategies we identified could be used to locate the emergence of conspiracy theories on social media. Such monitoring could inform public health agencies of average citizens' major concerns, questions, and doubts, so that public health agencies can develop better targeted content when communicating with the public on social media. Real-time monitoring of conspiracy theorizing activities could also provide accurate information to counter some conspiracy theorizing discursive strategies. For example, when a conspiracy theorist cites authoritative information, public health professionals could join social media discussions and provide more credible interpretations of cited information. Additionally, public health agencies can predictively release information, because conspiracy theories during the Zika outbreak can potentially share similarities with conspiracy theories generated in future public health crises. For example, the fact that so many people were concerned with Zika origins suggests that future public health agencies should focus on explaining the origin of diseases to the public.

Social media design should consider ways to promote quality social media discussions. This is particularly important amidst recent media coverage about the negative effects of "fake news" and concern about consumers' ability to differentiate fake news from factual news [68]. As conspiracy theories develop on

general-purpose social media such as Reddit, Facebook, and Twitter, it is important to promote positive interventions that could identify and address people's specific information needs. For example, when someone cites an outdated news article to start a conspiracy theory, news recommendation algorithms might suggest the latest news. Machine learning methods could also be deployed to cluster conversations focused on the same topic but with diverse narratives or conclusions, so that people can be exposed to diverse stories, potentially even including conspiracy theories. CSCW and HCI researchers are ideally positioned to take the lead on design and development of conspiracy theory interventions.

8 LIMITATIONS

In this paper, we focused on conspiracy talk where people attempted to *build up* conspiracy theories. We did not systematically discuss people's *corrective efforts* to counter and weaken conspiracy theories. However, we did observe the presence of cases where people attempted to take corrective action against conspiracy theorizing. Future work should explore these corrective efforts on Reddit.

Another limitation is that, while we attempted to make our sample of Reddit posts representative by choosing posts from various subreddits, we have little information regarding how each subreddit was moderated. We expect that our study's findings are subject to whether moderators of certain subreddits actively removed certain conspiracy theorizing talk. In future research, these critical issues need to be closely scrutinized.

Finally, this study is focused on conspiracy theorizing, not the individuals that performed the talk. It is possible that people with certain personalities are more likely to participate in conspiracy theorizing, which might be recognizable through their post history on Reddit. In future research, we can also pay more attention to the posting behavior of individual conspiracy theorists to see if they have consistent conspiracy-oriented discursive patterns.

9 CONCLUSION

This study reports a nuanced qualitative analysis of conspiracy theorizing on Reddit in the face of the Zika pandemic. We present a general picture of what the conspiracy theories were, and how they were proposed and developed. Through conspiracy theorizing, people on Reddit collectively developed plausible explanations to cope with extreme uncertainty within the Zika crisis. The interface design of Reddit facilitated conspiracy theorizing in important ways such as collective elaboration of conspiracy details between two conspiracy theorists. It is perhaps unsurprising that sophisticated and influential conspiracy theories originate from Reddit and other similar sites before being widely circulated across multiple social media platforms and mainstream news outlets. In times that social media users gain more power in producing conspiracy theories that have a huge impact on societies, CSCW researchers and public health practitioners shall pay more attention to understanding the construction of conspiracy theories that reflect people's concerns, beliefs, and values.

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