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Mental Models of Infectious Diseases and Public Understanding of COVID-19 Prevention

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ABSTRACT

The emergence of viral diseases such as Ebola virus disease, Zika virus disease, and the coronavirus disease (COVID-19) has posed considerable challenges to health care systems around the world. Public health strategy to address emerging infectious diseases has depended in part on human behavior change and yet the perceptions and knowledge motivating that behavior have been at times inconsistent with the latest consensus of peer-reviewed science. Part of that disjuncture likely involves the existence and persistence of past ideas about other diseases. To forecast and prepare for future epidemic and pandemic response, we need to better understand how people approach emerging infectious diseases as objects of public opinion during the periods when such diseases first become salient at a population level. In this essay, we explore two examples of how existing mental models of past infectious diseases appear to have conditioned and constrained public response to novel viral diseases. We review previously reported experiences related to Zika virus in Central America and discuss public opinion data collected in the early months of the COVID-19 pandemic. In the case of Zika virus disease, we assess how thinking about earlier mosquito-borne disease seems to have affected public consideration of the virus in Guatemala. In the case of COVID-19, we assess how previous vaccination behavior for a different disease is associated with intention to obtain vaccination for COVID-19 in the future.

The emergence of viral diseases such as Ebola virus disease, Zika virus disease, and COVID-19 has posed considerable challenges to health care systems around the world. As novel diseases, these threats to public health reflect in part a lack of effective treatment or vaccines. The novelty of these diseases, however, also has posed threats related to public understanding. Public health strategy has depended on human behavior change and yet the perceptions and knowledge motivating that behavior have been at times inconsistent with the latest consensus of peer-reviewed science. Part of that disjuncture likely involves the existence and persistence of past ideas about other diseases. To forecast and prepare for future epidemic and pandemic response, we need to better understand how people approach emerging infectious diseases as objects of public opinion during the periods when such diseases first become salient at a population level.

In this essay, we explore two examples of how existing mental models of infectious disease appear to have conditioned and constrained public response to novel viral diseases. We review previously reported experiences related to Zika virus in Central America and discuss public opinion data collected in the early months of the COVID-19 pandemic. In the case of Zika virus disease, we explore how thinking about earlier mosquito-borne disease seems to have affected public consideration of the virus in Guatemala. In the case of COVID-19, we assess how previous vaccination behavior for a different disease is associated with intention to obtain vaccination for COVID-19 in the future (which at the time of the survey was only a hypothetical possibility).

People represent the physical world around them in their cognition. Mental models are elements of that cognition: representations that comprise how people conceptualize a phenomenon (Craik, 1967; Johnson-Laird, 1983; Jones et al., 2011; Morgan et al., 2001). Those models can vary in complexity and dimensions and can change over time. We might think of them as constellations of ideas that a person holds that together offer a mental representation of a concept. For example, people might consider a house as a structure with a roof and doors and windows in which people live; they may or may not have ideas about the materials used for the walls or whether a door opens into the house or outward or whether there is a mechanical cooling system. The complexity and dimensions of a person's mental model, in turn, can constrain or facilitate engagement with new information about that phenomenon.

On a related note, we also can consider evidence that existing conceptualization conditions people's encounters with new information in the literature on anchoring bias. Tversky and Kahneman (1974) wrote about anchoring bias decades ago as a human tendency to rely on an initial piece of information even when new information comes to light. Researchers have investigated the phenomenon in numerous contexts, including the situations as varied as clinician diagnosis of disease based on ambiguous symptoms (Iwai et al., 2018) and real estate property value appraisal (Unveren & Baycar, 2019). How people think about a phenomenon has at least some tendency to persist despite new information. This tendency offers us some

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value; if not, we can imagine human experience to be constantly bewildering and chaotic from moment to moment. That persistence, while cognitively useful in some sense, nonetheless also can bias us in unhelpful ways sometimes.

How might predominant mental models of infectious disease inform communication opportunities and efforts? In short, past consideration of previous diseases sets the stage for at least initial consideration of novel diseases. Prior experiences afford some opportunities for public communication but also can leave us vulnerable to blind spots regarding unique aspects of emerging diseases and can pose unappreciated challenges for communication campaign design.

Zika virus understanding as a function of mosquito-borne disease understanding

As reported previously (Southwell et al., 2018), RTI International studied how people perceived Zika virus in spring 2016 amidst an outbreak in Guatemala. Staff conducted eight focus groups (separately for men and women) and 10 in-depth individual interviews with adults, 18- to 49-years-old, in Spanish. Interviews occurred in two departments of Guatemala (Zacapa and Suchitepéquez).

Virtually all participants said that they were aware of Zika virus disease at the time of the interviews. At the same time, participants also talked about Zika virus in a manner that clearly reflected their past experiences with other mosquito-borne diseases. That is understandable: dengue fever has been endemic in Guatemala for years and there was a substantial outbreak of chikungunya disease in 2014. Participants apparently drew on experience with dengue and chikungunya as a baseline in understanding Zika virus. Most participants noted that mosquitoes were a vector for the Zika virus, for example, and participants often pointed out that the type of mosquito that transmitted Zika also was responsible for chikungunya and dengue. Some participants did make distinctions between the mosquito-borne diseases they mentioned, such as conjunctivitis (red eyes) as a symptom distinguishing Zika from other diseases. Even in such cases, however, dengue and chikungunya seemed to serve as an anchoring reference against which to compare Zika virus.

Why would this conceptualization of Zika virus disease as simply another mosquito-borne disease matter for public health communication efforts? One important consideration is that Zika virus is not solely a mosquito-borne disease. Zika virus can be sexually transmitted from person to person in addition to being transmitted by mosquitoes, e.g., Oster et al. (2016), information that seemed not to be a primary consideration for many of the respondents in the study. Moreover, even after hearing about the possibility of sexual transmission, multiple respondents said they would base their sexual behavior on the appearance of obvious symptoms of Zika virus in a partner and yet we know that Zika virus infection is not always accompanied by visually obvious symptoms.

COVID-19 vaccination willingness as a function of past influenza vaccination behavior

In mid-April 2020, RTI International invited U.S. respondents from a national panel (built through probability and address-based sampling) to a survey on COVID-19 perceptions. Sampled respondents received a link to an online survey, which was available in both English and Spanish. A total of 2,279 participants responded to the survey for a completion rate of approximately 34%. (Approximately, 227 respondents completed the survey in Spanish.) The RTI Institutional Review Board reviewed the protocol and survey. Once data were collected, a poststratification process was used to adjust for survey nonresponse, noncoverage, undersampling, or oversampling by using benchmarks from the Current Population Survey (https://www.census.gov/programs-surveys/cps.html) and scaling the sample size to the number of qualified respondents.

The survey included questions about willingness to get a vaccine for COVID-19 (both for oneself and one's child when applicable) when one becomes available as well as *influenza* vaccination behavior in the past year. (The survey item asked about willingness to get vaccination for "Coronavirus" specifically.) The measure of past influenza vaccination should be predictive of future COVID-19 vaccination willingness if respondents conceptualized COVID-19 as being related to influenza in some fashion. In other words, past influenza vaccination behavior should correlate with future hypothetical COVID-19 vaccination willingness if a predominant mental model of COVID-19 classifies the new phenomenon as an infectious disease conceivably subject to the effects of vaccines.

Results of the survey support that hypothesis. Respondents who had received an influenza vaccine in the past year reported that they were more willing to get a Coronavirus vaccine when one becomes available, both for themselves (89% vs. 59%, $p < .001$) and for a child (83% vs. 56%, $p < .001$). (See Table 1.). Past influenza vaccination behavior predicted willingness to get a COVID-19 vaccine in the future among Americans.

If intention toward future prevention behavior is rooted in part in preexisting preventive behavior related to other infectious diseases (or in hesitancy toward such behavior), communication professionals preparing to encourage COVID-19 prevention should recognize that audiences are not blank slates. Popular perceptions of infectious disease offer part of the foundation on which new conversations with audiences will rest.

Discussion

These two examples highlight specific ways in which existing experience with infectious disease can shape public understanding of novel infectious diseases and willingness to engage in preventive medical actions. In the case of Zika virus, it appears that respondents in Guatemala in 2016 overlooked the potential for sexual transmission as they were conceptualizing Zika virus disease as another mosquito-borne disease. In the case of COVID-19, we have evidence that past behavior concerning influenza preventive action predicts COVID-19 vaccination, even though influenza and COVID-19 stem from distinct viruses. Without considering the likely influence of existing mental models of

Table 1. Bivariate association between past flu vaccine behavior and willingness to vaccinate for coronavirus.

Variable	Received Flu Shot in Past Year	Did Not Receive Flu Shot in Past Year	Chi-square test	p-value
	Weighted N (%)	Weighted N (%)		
When a vaccine for the Coronavirus becomes available, I will get it.				
Strongly agree/agree	1082 (89)	603 (59)	$\chi^2(1) = 293.38$	< 0.001
Strongly disagree/disagree	128 (11)	420 (41)		
When a vaccine for the Coronavirus becomes available, I will have my child get it.				
Strongly agree/agree	737 (83)	422 (56)	$\chi^2(1) = 151.50$	< 0.001
Strongly disagree/disagree	148 (17)	331 (44)		

disease, communication professionals might overlook the need to emphasize novel transmission pathways. Communication professionals also might inadequately address other existing conceptions of viral disease.

Predominant mental models of COVID-19 vaccination (which at the time of the spring 2020 survey was only a hypothetical possibility) may include either deference to or rejection of past public health vaccination recommendations. Nonetheless, communication professionals should recognize that baseline consideration of COVID-19 vaccination for many people will include the notion of vaccination generally or for other diseases. Future effort to promote COVID-19 vaccination or other prevention or treatment measures will not face blank slates among audiences. Insofar as COVID-19 operates distinctly from the various forms of influenza, public imagination that groups together viral diseases could pose barriers to cooperation with public health intervention (especially in the case of vaccine hesitancy). Public reliance on past thinking about influenza vaccines when considering COVID-19 vaccines might be problematic, for example, given that past influenza vaccines have not always perfectly matched actual strains circulating (Cohen, 2017) whereas we might see different efficacy for a new COVID-19 vaccine.

Despite the challenges of existing mental models of disease for communication about emerging infectious diseases, we also should recognize the possibility for mental models to evolve and grow over time, especially with adequate public health education. It is unlikely we can successfully introduce wholesale new concepts about infectious disease to audiences without any reference to their past experiences, but it also should be possible to build upon and add to existing conceptualization in productive ways.

Moreover, past understanding might even afford communication opportunities to underscore reasons for hope and motivate recommendation adherence by referring to the past. Here we can recognize the value of our collective cultural experience with infectious diseases over time. During the 1918 influenza pandemic or during the decades of struggle with polio that we faced in the mid-20th century, accurate understanding of how viruses work often was missing from popular discourse until scientists actually isolated the viruses now associated with each disease or developed vaccines, e.g., Barberis et al. (2016) or Koprowski (2006). Relative to more recent decades, communication professionals during those periods had to address populations that lacked accurate basic understanding of the viral threats we faced. As we face the new viral diseases of the 21st century, we can draw on past pandemic response as a useful source of hope and past scientific discovery of viruses as a microscopic threat to public health as promise that we will continue to make new discoveries that help.

In the early days of engagement with any newly emerging infectious disease, health communication professionals should consider lessons learned from other diseases that might be salient for populations threatened by the new disease. Scanning the information environment for evidence of how past news coverage and popular media content has framed other diseases and accounting for existing public perception data on related diseases are reasonable steps to take in preparing for new infectious disease communication efforts. In addition, conducting primary data collection to assess prevalent mental models can offer a foundation for communication interventions. Acknowledging existing biases, awareness, and even misunderstanding held by audiences will improve our ability to craft communication efforts that respectfully introduce the unique aspects of new public health threats to people who are largely trying to keep themselves and their loved ones healthy.

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