

# **Building cognitive security and resilience to enhance crisis preparedness: A social ecological approach to minimizing information-based harms**

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## **ABSTRACT**

Information crises co-occur alongside most natural and human crises. Widespread use of social media complicates these intertwined crises with new opportunities and challenges. Greater individual and societal resiliency helps offset information-based vulnerabilities and harms; however, most research in this area lacks systemic theory-driven research on the dynamic relationship between the individual and their environment. This paper uses a novel adaptation of Brofenbrenner’s social ecological model (SEM) to the study of cognitive security and resilience in the context of crisis-related information behaviors and information-based harms through two case studies: the international 2014-2016 Ebola outbreak and U.S. mass shootings. Our findings highlight the fluid nature of information-related dynamics during major crisis events, underscoring how the resilience of individuals in crisis situations both influences and is influenced by higher-level systems and processes. The model can help identify, prioritize, and evaluate future information-related initiatives and interventions, and extends SEM conceptual foundations for information research.

## **KEYWORDS**

Cognitive security; Social ecological model; Information harm; Crisis information behavior; Case study

## **INTRODUCTION**

The integrity of our information systems is a crucial aspect of crisis preparedness, response, and recovery, but the very nature of crises themselves presents a significant challenge to these systems and those who rely on them. Nearly every major crisis in recent history — including weather and climate-related disasters, disease outbreaks, terrorist attacks, and more — has been compounded by a co-occurring information crisis (Fraser & Fitchett, 2022; Huang *et al.*, 2015; Lee *et al.*, 2021; Sell, Hosangadi, & Trotochau, 2020); yet at the same time, the widespread use of social media during crises has also created new opportunities for emergency communication, real-time disaster surveillance, crowdsourcing, informal volunteerism, community outreach, and collaborative engagement (Reuter & Kaufhold, 2018). The coronavirus pandemic and accompanying “infodemic” highlighted the dire consequences of underrecognized information-related vulnerabilities, resulting in newfound interest in bolstering individual and societal resilience to information-based harms. To date, most research in this area has focused either on the individual or on the information environment (or on the technology that allows an individual to access the information environment), but there is a lack of systematic, theory-driven research on the dynamic relationship between the individual and their environment (Janzen, Orr, & Terp, 2022).

In this paper, we propose a novel application of Brofenbrenner’s social ecological model (SEM) (Brofenbrenner, 1979) to the study of crisis-related information dynamics, with a focus on identifying common factors associated with cognitive vulnerability and resilience in the face of information-based harms. This paper builds on prior work in which we adapted the SEM framework to the study of COVID vaccine-related informational harms, refitting the model from its origins in human development and public health and applying it to the context of cognitive security and resilience as a first step towards developing a more comprehensive conceptual model of the multi-level, dynamic factors that influence cognitive security-related processes and outcomes across a variety of contexts and events (Janzen, Orr, & Terp, 2022). To our knowledge, this line of work represents the first application of the SEM in its entirety as a conceptual and theoretical foundation for the study of crisis-related cognitive security and resilience.

This paper begins with a brief description of the SEM, then presents a pair of case studies — grounded in extant literature, field notes, situation reports, and more — applying the SEM to the context of crisis informatics and crisis-related information behaviors across two unique settings: the 2014–2016 Ebola outbreak, and mass shootings in the United States of America (U.S.).

## **SOCIAL ECOLOGICAL MODEL**

While the levels of the SEM have been conceptualized and labeled in different ways over the course of the past five decades, this study builds on a version of the model that is widely used in public health, health promotion, and behavior change research. This framework, an adaptation of Bronfenbrenner’s model put forth by McLeroy and colleagues, specifies five levels of influence that interact with each other and with the individual, starting with the individual level, which encompasses the most proximal layer of influences such as demographic factors, identity, political ideology, moral foundations, attitudes, beliefs, emotions, knowledge/skills, behaviors, and more. The second level of the model, the interpersonal level, comprises the external social influences of family, friends, and other close relationships, as well as related social factors such as group norms and social support. The organizational level of influence describes the organizations and institutions in which social relationships occur and in which policies and regulations originate. This includes local, state, federal, and global organizations and agencies such as police departments, universities, hospitals, corporations, NGOs, and more. The next level of influence is the community level, which focuses on the networks that connect organizations and institutions, the settings in which they exist, and the culture and norms that emanate from these spaces. Examples include the public health community, the global aid community, the information security community, and the education community. The fifth level is the policy/societal level, which includes broad societal factors that create a climate in which certain practices, behaviors, and phenomena are either reinforced/encouraged or inhibited/discouraged, as well as factors such as poverty, inequality, discrimination and bias, and strength of democracy. This level also includes the policies that create or reduce poverty, inequality, discrimination, and related factors, as well as policies focused on technology, information, security, and defense. For the purposes of this study, we chose to describe these layers separately, as we identified several key areas where policy and society were moving at different speeds, and/or where coalitions involved in policy-making spanned numerous, heterogeneous societies and thus were not accurately captured in a single level. Figure 1 illustrates the SEM levels and major factors within each level.

Since its inception in the 1970s, the SEM has been used as a framework for research and program planning in a variety of fields, particularly within the areas of human development, public health, and intervention planning. (Golden & Earp, 2012; Richard, Gauvin, & Raine, 2011). In recent years, increasing attention has been given to ecological models like the SEM, in large part because our increasingly interconnected society has brought into focus the crucial role of relationships, networks, norms, and culture in shaping human behavior. However, there remain few applications of the SEM or related models in the area of information-based harms, despite a significant amount of overlap between the study of cognitive security and the fields of public health and behavioral science. In this paper, we define cognitive security as the ability to detect, characterize, and counter misinformation, disinformation, and other information-based harms and forms of malign influence. Resilience, as part of cognitive security, includes the structural context that protects humans from exposure to disinformation in the first place, as well as the ability to identify it, limit its spread, and mitigate its effects once exposed. We also include the ability to effectively, securely, and reliably utilize and preserve critical information in our definition of cognitive security. Furthermore, throughout this discussion, we consider different stages of cognitive security, including planning and preparation of responses, prediction and prevention, intervention and interdiction, and reaction and recovery.

## **Methods**

In this paper, we apply the SEM to a series of case studies involving crisis informatics and crisis-related information behaviors, with a focus on the role of social media in facilitating dissemination of, access to, and engagement with information before, during, and after crises. We use these case studies to systematically identify and characterize information-related vulnerabilities at each level of the SEM, describing how these factors have manifested and influenced the nature and course of historical crises. Using extant literature in the field, we identify the key factors at each level of the SEM — including individual-level factors such as fear, risk perceptions, and political ideology, as well as higher-level factors at the interpersonal-, organizational/institutional-, community-, and policy/societal-levels — that influence cognitive security in the crisis context and underlie decisions about who and what to trust during times of crisis, and therefore shape our susceptibility and resilience to information-related harms. We also make explicit the dynamic interactions between individuals, groups, societies, and characteristics of the technological and information environments.

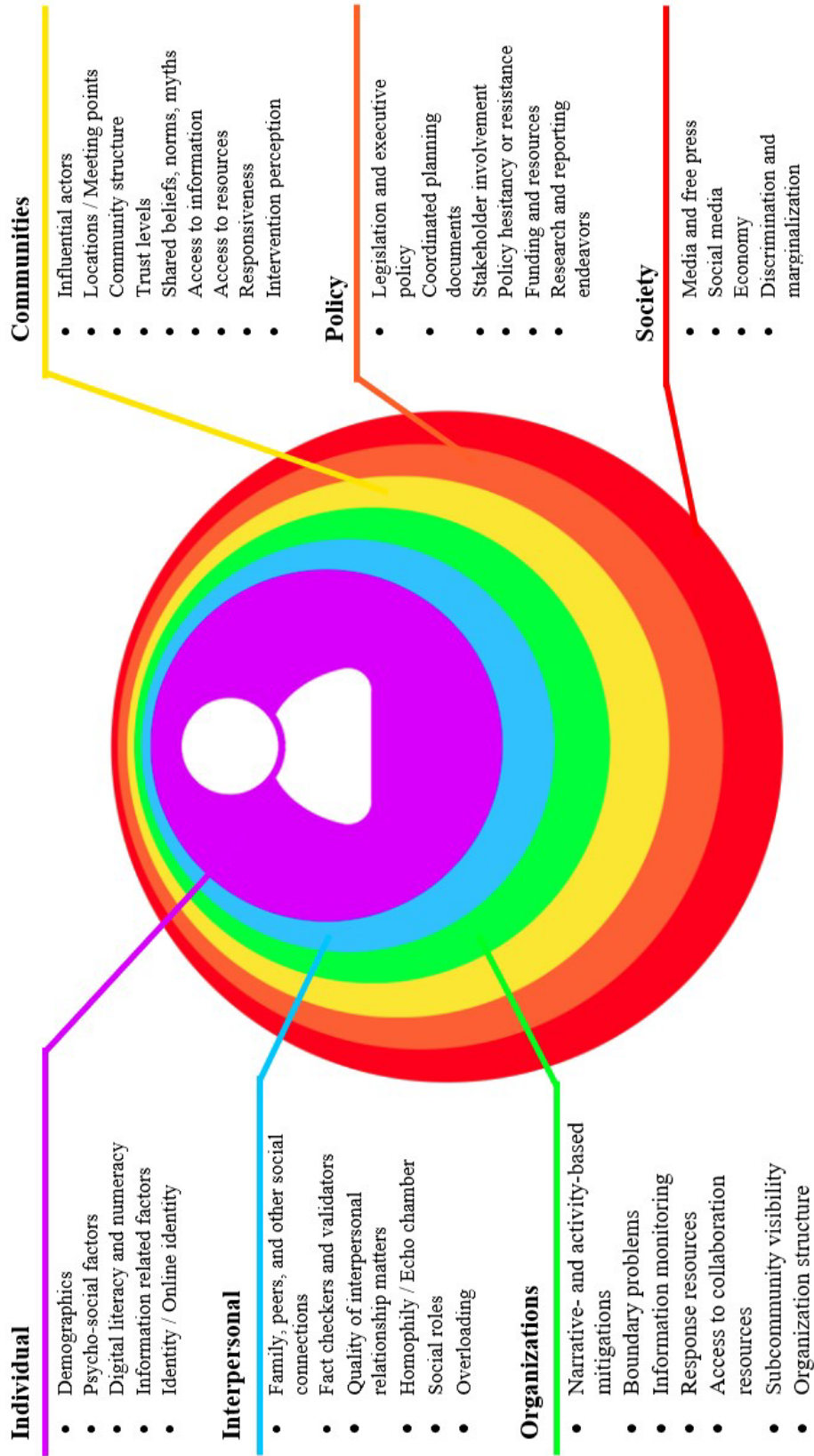


Figure 1: The Social Ecological Model (SEM)

Specifically, we present two case studies examining information-related crises surrounding 1) the Ebola epidemic of 2014-2016, and 2) mass shooting events in the U.S. Findings shed light on how common underlying factors at various levels of the SEM — including emotions such as fear (individual level), lack of interpersonal and institutional trust (interpersonal and organizational levels), poor communication (interpersonal and organizational levels), lack of coordination between responding organizations (community and organizational levels), reactive rather than proactive policies (policy level), and reframed narratives by the press media (society level) — created vulnerabilities and contributed to information crises that compounded the initial crisis event. Our case studies also highlight the evolving role of social media as both a tool for disseminating timely emergency updates, as well as a vulnerable space for rumors and a weapon for exploitation as part of disinformation campaigns and other malign influence operations. During the Ebola epidemic, a disinformation campaign created panic when a verified news account tweeted a false report about an Ebola outbreak in Atlanta. This came amid a flurry of mis- and disinformation about the virus, mostly targeting West Africa but also the U.S. and Europe. Ultimately, this resulted in a climate of mistrust that diminished the ability of official government agencies to use social media to communicate emergency messages to the public. During the recent mass shooting in Uvalde, Texas, poor communication between local and state agencies, as well as misinformation in official agency statements, resulted in an information vacuum that was quickly exploited and filled with mis- and disinformation on social media. The type of mis- and disinformation that was shared during this time was heavily influenced by broader cultural and societal trends, as evidenced by the anti-LGBTQ and anti-immigrant sentiment underlying much of this content.

Finally, we utilize these applied case studies at each level of the SEM to propose a framework for building and maintaining cognitive security and resilience as the foundation for future crisis preparedness efforts. This framework incorporates a variety of topical issues such as digital archiving and preserving social media data as part of the historical record, mining social media data for use in predictive analytics, identifying reliable methods of misinformation detection, establishing and maintaining public trust through ethical research practices, and reaching underserved and vulnerable communities. Examples stemming from the case studies include advances in methods of archival data collection and the creation of the Global Health Events web archive, the use of machine learning-based big data analytics for Ebola surveillance and mapping vulnerabilities, as well as the emerging ethical challenges that accompany disease surveillance data sharing. We also discuss ongoing issues and dilemmas such as the deletion of social media accounts and posts that violate platform policies, which removes false information from public consumption but also greatly limits the ability of researchers to study how such content may have affected information dynamics during the crisis. Similarly, we examine how cognitive biases such as survivorship bias may affect the quality of data models used in crisis informatics, such as when certain vulnerable populations stop posting on social media during the transition from a non-crisis state to a crisis state, resulting in a loss of data that is often overlooked in studies of crisis-related social media posts. Furthermore, we also discuss the problem of data voids, particularly during crises, and propose novel solutions for mitigating the risks they present.

## CASE STUDIES

### Ebola

#### *Introduction*

The Ebola epidemic of 2014-2016 was the largest outbreak of the disease in recorded history, resulting in nearly 29,000 infections and more than 11,000 deaths. By the time the World Health Organization (WHO) officially declared an Ebola outbreak in late March 2014, the virus had already been spreading — largely undetected — for three months, and had crossed from Guinea into the neighboring countries of Liberia and Sierra Leone. The epidemic mainly affected the West African nations of Liberia, Sierra Leone, and Guinea, but cases were also documented in the United States, the United Kingdom, Italy, Spain, Nigeria, Senegal, and Mali. On September 30, 2014, the U.S. Centers for Disease Control and Prevention (CDC) confirmed the first travel-associated case of Ebola in the U.S. (CDC, 2020), prompting a flood of media coverage — much of which was politically- and emotionally-charged — and an accompanying surge of fear and maladaptive responses, “including violations of the International Health Regulations and the treatment of potentially exposed individuals” (Roberts *et al.*, 2017). The associated information crisis was vast, encompassing on-the-ground social networks, traditional media, social media, official government and agency communications, and more. Mis- and disinformation thrived on social media, yet many major health organizations failed to use their social media messaging to combat Ebola-related myths and conspiracy theories (Guidry *et al.*, 2017). The loss of trust in institutions and the medical community stemming from the Ebola-related information crisis is widely thought to have complicated disease control efforts, prolonged the outbreak, and resulted in excess suffering and death (Blair *et al.*, 2017; Richards *et al.*, 2019). The following brief case report describes the Ebola-related information crisis, analyzing

the key cognitive security-related factors at each level of the SEM as well as their role in shaping the course of the disease epidemic.

### *Individual level*

One of the key individual-level cognitive security challenges during the Ebola epidemic was accurately conveying risk while avoiding fear- or anger-inducing messages. Research suggests that attention to and fear of Ebola decreased as a function of spatial and psychological distance (Lent *et al.*, 2017), which may explain why the U.S. public largely ignored information about preparing for Ebola, despite intense media coverage of the outbreak (Yang, 2019). Furthermore, emotions and perceptions of risk may have influenced information-seeking behavior and subsequent information processing, which may have ultimately shaped how the public responded to Ebola, and how they viewed the government's response to Ebola (*ibid*). On an individual level, greater exposure to media — particularly graphic media, such as pictures of dead bodies — was associated with increased fear and worry, and higher perceived risk among Americans (Garfin *et al.*, 2022). Higher perceived risk was associated with performing more health protective behaviors, but at a cost: Situations in which high perceived risk was paired with low self-, collective-, and proxy-efficacy to engage in actions to reduce risk ultimately led to “fear control” responses, a maladaptive emotional process that promotes defensive avoidance behaviors (Li, 2018). However, when self-efficacy and proxy-efficacy (defined as “an individual's belief in a third party's positive involvement in the individual's own goal fulfillment”) were high, individuals were more likely to engage in danger-control behaviors — the result of a cognitive process whereby individuals develop protective strategies to reduce their chances of being affected by a given threat. As self-efficacy increased, individuals were more likely to engage in danger control behaviors, rather than fear control behaviors, to deal with a perceived threat, which is in line with the tenets of the Extended Parallel Process Model (Witte, 1994). As such, the information people are exposed to and engage with — via the media, social media, and other means — shapes individuals' perceptions of the event, the threat it poses, their options for mitigating the threat, and their actual response to it. This also relates to the perceived competence of physicians and other health professionals to communicate essential information to the public. According to one study, just half (52%) of internists in the U.S. reported feeling prepared to communicate information about or diagnose Ebola, which may have limited the ability of the medical community to effectively disseminate information, answer questions, and accurately convey risk (Ganguli *et al.*, 2015). Factors related to information-processing and attention also played a key role in individuals' information-related behaviors, as messages accompanied by visual imagery elicited increased engagement (Houts *et al.*, 2006; Vos *et al.*, 2020). Additionally, fear, anger, anxiety, disgust, and sadness were found to be key emotional variables that mediated the relationship between cognitive appraisals of risk and health-related behaviors (Yang & Chu, 2018).

### *Interpersonal level*

Ebola spreads through close contact, so relationships and social networks are key. Studies examining how information sources and trust in those sources influence risk perceptions and self-efficacy indicate that interpersonal sources — both traditional and mediated — were preferred and received with a higher level of trust in countries both affected by Ebola (Liberia) and nearby but not affected (Ghana), but there was considerable nuance in the type of interpersonal sources deemed to be trustworthy, and the effects of such communication were variable (Thompson, 2022). For example, after the first Ebola death in the U.S., exposure to Ebola-related information via interpersonal sources such as friends, family, coworkers, and acquaintances was associated with greater levels of fear (Dillard & Yang, 2019). Social media played a significant role in facilitating communication and information-sharing among members of communities affected by the Ebola virus, as well as between persons living in affected regions and their friends/families in the U.S. (Williams *et al.*, 2018). However, this was also a route through which rumors and inaccurate and/or incomplete information was shared, which ultimately created distrust in interpersonal relationships. Influencers on social media, up to and including the future president of the United States, Donald Trump, had an outsized effect on social media discourse, often setting off waves of apocalyptic rhetoric that spread through social media communities and set the tone of conversation (Salek & Cole, 2019). The spread of information on Twitter followed a diffusion pattern consistent with “broadcasting,” rather than true viral spreading (Liang *et al.*, 2019). Additionally, a “contagion effect” has been observed in patterns of Ebola-related information spread, with each Ebola-related news story inspiring tens of thousands of Ebola-related tweets and Google searches — even in areas that were largely unaffected by the virus, like the U.S. (Towers *et al.*, 2015). However, certain instances of Ebola-related virality on social media may have taken on an almost therapeutic role for some internet users. For example, the creation and spread of Ebola memes have been conceptualized by some researchers as a social response to the epidemic and an example of “disaster humor” (Marcus & Singer, 2017). Offline, interpersonal factors such as stigma were major concerns during and after the Ebola outbreak, particularly for survivors and frontline health workers (Gee & Skovdal,

2018). Survivors and those with firsthand experience with Ebola can play an integral role in educating others and reducing fears about the disease, but stigma prevents many of these individuals from engaging in community outreach and even from being included in efforts to better prepare for future outbreaks (Carter *et al.*, 2017).

#### *Organizational level*

Partnerships between the government and NGO's were critical to containing and eventually ending the outbreak and its associated information crisis, as well as preparing for future outbreaks and black swan events. During the outbreak, organizations applied novel approaches to both formal and informal rumor identification and management as a way of monitoring the information environment and addressing potential risks or problems that may not be reported through official channels (Brandt, Katalenich, & Seal, 2021). "Studying informal rumor identification and management techniques can provide unique insights into bottom-up approaches to addressing rumors," one study concluded (*ibid*). Other organizations developed systems for ethical and secure management of large databases containing vast amounts of data collected from a variety of sources, including call centers, testing laboratories, case investigations, and burial records (Agnihotri *et al.*, 2021). These data were then compiled in one main data consolidation effort, which provided a unique opportunity for researchers to improve responses to outbreaks and include data management preparedness in emergency response plans. In the U.S., organizations responded to the emergency by forming initiatives like the Chicago Ebola Response Network (CERN), a network of 4 academic centers that share expertise, risk, and resources with the goal of being better able to anticipate, manage, and prevent the next black swan event (Lateef *et al.*, 2015). Overall, though, most post-mortems assessing the U.S. Ebola response paint a picture of an unprepared nation plagued by poor communication and coordination, with local, state, and federal agencies often relying on different and sometimes contradictory emergency protocols. A June 2016 independent review of the U.S. Health and Human Services (HHS) Ebola response concluded that "HHS is not configured or funded to respond to a prolonged public health or medical emergency overseas or at home" (Fielding *et al.*, 2016: iv). The report also found that different levels of government (federal, state, and local) had "different—and, at times, conflicting—policies and authorities for specific response measures, such as waste management and quarantine." Furthermore, according to the report, HHS did not demonstrate an appreciation of the public's perceptions and fear of Ebola virus, particularly in early communication. The report also provided numerous recommendations based on deficiencies that emerged during the 2014-2016 outbreak, including a recommendation that HHS clarify its strategy for communicating risk-related information to the public, to Congress, and to other key stakeholders. This included a specific directive to develop a public communication framework that fully integrates crisis and emergency response communication principles. A 2019 study assessing capabilities, challenges, and needs at America's 56 Ebola treatment centers (ETC's) found that, five years after the Ebola outbreak began, U.S. preparedness capabilities are reduced (Herstein *et al.*, 2020). The study concluded: "More research, support, and funding are needed to sustain the unique knowledge and proficiency acquired by ETC teams to ensure domestic preparedness for highly hazardous communicable diseases."

#### *Community level*

Community mobilization — particularly the involvement of trusted "key informants," community health workers, and leaders from local neighborhoods, religious communities, public health agencies, hospitals, and other formally- and informally-connected networks of individuals — is considered a critical component of outbreak response and control, yet it has often been overlooked or minimized by those organizing on-the-ground efforts. For example, research suggests that insensitivity to local culture and an inability to listen to or empathize with community needs fuels resistance to early detection during the initial phases of an outbreak, when risk of transmission is highest. Additionally, differences in language, dialect, and non-verbal communication may be a significant barrier to the transmission of accurate, timely information (de Vries *et al.*, 2016). "Despite remarkable technological innovations, outbreak control remains contingent upon human interaction and openness to cultural difference," de Vries and colleagues wrote in a 2016 report based on ethnographic research conducted at the center of a 2012 Ebola outbreak in Uganda (*ibid*). Cultural characteristics of online communities also played a role in the Ebola information crisis and influenced how narratives were constructed and maintained. This was not always an organic process, as health agencies often worked with influencers in online communities to help construct and propagate certain narratives, such as those framing frontline health workers as heroes (Roy *et al.*, 2021).

#### *Policy level*

Even before a single Ebola case was reported in the U.S., politicians were already engaged in a fierce battle over how to keep the virus out of the country, and many were quick to implement reactive policies driven largely by misinformation, partisanship, and emotion (American Civil Liberties Union & Global Health Justice Partnership,

2015). Politics, rather than epidemiology or public health, guided much of the policy response, and many governors — particularly in the northeastern U.S. but also in Texas and elsewhere — rejected the public health consensus on how to best handle the virus, and chose instead to impose mandatory quarantines of health workers and visitors from West Africa. By December 2014 — two months after the first case was reported in the U.S. — at least 23 states had imposed quarantine and movement restriction policies that exceeded CDC guidelines (Global Health Justice Partnership, n.d.). Several dozen infectious disease specialists, including Ebola researchers, were prohibited from attending the annual meetings of the American Society of Tropical Medicine and Hygiene (ASTMH) and the American Public Health Association (APHA) in October 2014 when the state of Louisiana issued a ban on anyone coming from the affected region — regardless of whether they had contact with any Ebola patients (Asgary *et al.*, 2015). As a result, many international aid organizations based in the U.S. spent so much time dealing with quarantine policies that they were unable to adequately carry out their primary mission of stopping the outbreak at its source (ACLU & GHJP, 2015). Furthermore, according to the American Civil Liberties Union (ACLU), the U.S. response to the Ebola outbreak resulted in a number of violations of human and civil rights, including failing to safeguard due process rights, quarantining individuals under inhumane conditions, imposing quarantines and movement restrictions that were scientifically unjustified when less restrictive alternatives were available (*ibid*). With politicians and the media stoking fears about the outbreak, many of these overly-restrictive policies were widely supported by the American public, while more rational discussion was largely confined to the margins.

### *Societal level*

As the U.S. Department of Defense (DOD) described, the Ebola outbreak took place in a “socio-cultural ecosystem particularly ill-suited to stop it” (Joint and Coalition Operational Analysis, 2015: 1). One major concern stemming from the Ebola epidemic was the possible loss of societal trust and confidence in medical institutions and the scientific process more generally. Because of the great deal of uncertainty associated with Ebola, the scientific and medical communities were presented with the challenge of communicating accurate information and reassuring the public, while also leaving room for unknowns and possible errors in predictive forecasts, whether about transmission of the virus, the associated fatality rate, or the potential size of the outbreak (Rosenbaum, 2015). Media coverage exacerbated this challenge and played an extremely important role in shaping perceptions of the outbreak, its severity, and the threat it posed, as well as public support for (and opposition to) Ebola response measures. In information-based societies such as the U.S.A., the media is the primary means through which people seek out and obtain information, especially during crises (Garfin *et al.*, 2022). In many public health crises, the media is the main or only source of exposure to the illness for most individuals, which makes media coverage a particularly important source of risk-related information, including the nature of the risk and appropriate health protective behaviors. However, exaggerated representations of risk and/or lack of information about what people can do to protect themselves may lead to fear, dread, and activation of the stress response system, which itself can have long-term negative health consequences (*ibid*).

### *Integration*

Several key themes emerge across the levels of the SEM, including the diverse uses of social media and the divergent outcomes of such uses, with some beneficial outcomes such as information dissemination, community engagement, and social support, but also a variety of detrimental effects including increased fear, rumor propagation, and reputational damage to some health agencies and organizations. Another cross-cutting factor was the discrepancy — and often problematic chasm — in information-related dynamics between the epicenter of the outbreak in West Africa and countries like the U.S., which were largely unaffected by the actual virus but were the focus of a disproportionate amount of media coverage. Breakdowns in communication, followed by information-related harms, also spanned multiple levels of the SEM, with lack of trust as the primary variable underlying most of these problems. From interpersonal sources, to organizations, to the medical/scientific communities more broadly, loss of trust could perhaps be the defining characteristic of the Ebola-related information crisis. The interaction between levels of the SEM can be seen throughout the case study, such as in the case of health organizations using social media to respond to the fear-inducing rhetoric that was introduced by politicians.

## **Mass shootings**

### *Introduction*

There have been 504 mass killings in the U.S. since 2006, around 80% of which involved firearms (Zaiets *et al.*, 2022) and the FBI’s active shooter incident 20-year review showed active shooter rates at their highest in recent years (Gramlich, 2022; FBI, 2021). Mass shootings replace our sense of safety with tragedy; they occurred in our schools,

churches, shopping malls, and a wide range of other public and private locations. An information crisis surrounds mass shootings, as the truth distorts through communication narratives that reframe these traumatic events to shift the conversation focus, e.g., as cowboy westerns (Lemmons, 2021), or deny their authenticity, e.g., as staged productions (Snider, 2018; Sellnow, Parrish, & Sememas, 2019). Information harms related to mass shootings directly impact individuals from minor harassment to death threats (Citron, 2022) and carry secondary effects upward into communities, society, and policy decisions like firearm use (Chong, 2019). The information crisis pervading mass shootings is a wicked problem with complex, sociotechnical roots. This short case review on mass shootings will provide use-case descriptions of the SEM layers and discuss vulnerabilities in and opportunities to improve our cognitive security and resilience.

#### *Individual level*

At the individual level, information resilience is mediated by personal characteristics and experience, risk perception, cognitive and emotional appraisal. Our perceptions of events and emotional state can alter through information we encounter. Imagery shared during mass shooting events, and in the news cycle thereafter, of shooters armed with weapons and wearing tactical gear can lead adults to grief, intrusive thoughts, and other traumas, even if those adults were not directly connected to the event (Maslowski, 2022). Political and other ideologies also serve as cognitive filters to mass shootings, helping people rationalize the events and inform their reactions, such as increased calls to action on gun reform or carrying weapons (Lemmons, 2021).

#### *Interpersonal level*

Family, peers, and other social connections are integral to individual cognitive security and resilience at the interpersonal level. Families are often central networks of information and value sharing. Family discussions shaped individual opinions regarding how individuals viewed the mass shooters, and the shooter's circumstances and character (Schildkraut, 2018:13). During and in the aftermath of the Parkland, Florida shooting, thousands of bots flooded social media, appearing as grass roots discussions and infiltrating local peer conversations; the bots attempted to shape emotional reactions, instill doubts, and spread conspiracy theories, among other types of information harms (Kitzie, Mohammadi, & Karami, 2018).

#### *Organizations level*

Organizations play a key role as a defensive layer of resiliency, and security weakens when those organizations underperform, fail, or are absent when information harms appear. First responders from numerous law enforcement authorities were on-site at the school shooting in Uvalde, Texas, but breakdowns in leadership and communication failures were rampant. Information from police leadership was often absent or inaccurate, which echoed up through the Texas Governor's office and eroded public trust (Despart, 2022; McShane & Romero, 2022). Moreover, after-event reporting suggested that official communication responses suffered from misinformation (*ibid*), further weakening the effectiveness and accuracy of what should be credible institutions.

#### *Communities level*

Communities, composed of individuals sharing common interests, concerns, and identities, build or weaken mutual cognitive security and resilience through factors related such as trust, shared beliefs, and community-specific traits. Trust is a foundation upon which communities exist, but that same trust serves as a pass-filter for information harms. Rumors of potential mass shootings shared in private groups on social media platforms spread rapidly and are echoed by group members. A shooting rumor at an Indiana blueberry festival within a Facebook group with more than 5,000 members led to mass confusion within the group and an outpouring of concern to local police and news groups (Pietsch, 2019). Attempts by large social media platforms, such as Facebook, Twitter, and YouTube, to identify and reduce information harms on their sites led to the emergence of more extreme sites, such as BitChute, Rumble, and Odysee. More extreme social media sites claim to prioritize free speech rights, which then allowed for community messaging that referred to mass shootings in Buffalo, New York and Sandy Hook, Connecticut as false flags and hoaxes, increasing community member extremism, and enabling the U.S. January 6, 2022 Capitol Riots (Marshall & Tanfani, 2022). On the other hand, communities work to strengthen cognitive security and resilience against such information harms. Religious communities serve as a psychological and spiritual support in times of great tragedy, such as surviving or losing someone in a mass shooting (San Roman *et al.*, 2019).

#### *Policy level*

Mass shootings typically involve the policy level which affects government action, resource allocation, research, and stakeholder involvement. Mass shootings typically follow with heavily divided calls to action; on one side, political



interests call for greater gun control legislation and relaxed gun control on the other, both in the name of public safety and security. Depending on those political leanings and views on the U.S. 2<sup>nd</sup> Amendment, mass shootings are reframed as value-driven issues of good versus bad, right and wrong (Lemmons, 2021). Research from government and academia provides information to offset crisis information; yet, only since 2018 have U.S. federal agencies such as the National Institutes of Health (NIH) and Centers for Disease Control and Prevention (CDC) regained funding to conduct research on gun violations after clarifying the Dickey Amendment (Roston, 2018). The Dickey Amendment and similar legislative and executive policy is largely supported by the National Rifle Association (NRA), a massive stakeholder and influential lobbyist. Moreover, the NRA holds substantial sway over shooting related information spread, individual values and behavioral intent which translate into (Cheng & Shen, 2021; Thompson, 2019).

### *Society level*

President Joe Biden identified mass shootings as a challenge that threatens to “destroy the soul of the nation” (White House, 2022). Societal level factors that charge information harms related to mass shootings echo factors from other SEM levels and are amplified and reinforced by enduring systems that are resistant to change. Related to policy discussions around the U.S. 2<sup>nd</sup> Amendment, U.S. culture and ideology has deep ties to the right to bear arms. Interests to preserve these rights are tied to narratives that spin mass shooting events as moments of heroism portraying gun-wielding individuals as heroes over the active shooters. On the Fox news network, Sean Hannity leveraged mass shooting fake news tweets as media weapons against political leaders, like then President Barack Obama, even on topics beyond the scope of mass shootings (Chong, 2019). Likewise, Laura Ingraham spun mass shootings into a western narrative with epic cowboy elements (Lemmons, 2021) and portrayed antagonists as “the elites” framing them as evil, against good Christians, and taking slanderous, intolerant positions of gun supporters (Lemmons, 2021: 90). For nearly a decade, Alex Jones, via his show online radio show Info Wars, spread disinformation to millions of listeners that the Sandy Hook Elementary Shooting was a hoax and an elaborate ploy by crisis actors; and he pushed similar disinformation regarding mass shootings in Parkland and Las Vegas, as well as other mass tragedies (Vertuno, 2022).

Social media, as societal communication structures, offered an echo chamber for information harms. Disinformation from far-right ideological groups on Twitter tied together #GunReformNow and #NRA hashtag networks to promote conspiracy theories like hoax claims and false framing of heroic armed civilians stopping shooters (Chong, 2019). Sites like 4Chan mischaracterize individuals and wrongly identify them as shooters, as with Marcel Fontaine and the Parkland school shooting; this disinformation then propagates through media venues like Infowars and leads to modern-day witch hunts and real-world harms like verbal assaults in-person, online, and as death threats (Pilkington, 2019; Citron, 2020).

Discrimination and marginalization are also society level factors. Mass shootings are a form of community violence, but how these events are discussed and shared bridge these violent events to issues of racism and discrimination (Maslowski, 2022). Race and sexual orientation-related social tensions inflamed when and where social media amplified xenophobia and homo/transphobia disinformation and misinformation (Chong *et al.*, 2021). In the vacuum of accurate, official information during the Uvalde, Texas mass school shooting, disinformation campaigns promoted the shooter was transgender and stoked calls for anti-LGBTQ violence (Yousef, 2022). An earlier mass shooting in Buffalo, NY was tied to racist conspiracy theories and anti-immigrant sentiment; while many conservative politicians and news outlets were on the defensive about the shooting, they continued to communicate with similar disparaging messages (Montanaro, 2012).

### *Integration*

With respect to mass shootings, many factors within the SEM span multiple levels. Intersecting society and social media with organizations and policy, Austin *et al.* found gun violence advocacy and activism, often with anger and frustration emotional frames and “emphasis on conspiracy theories” on Instagram and issues of “untrustworthy entities and individuals” on Twitter (2020: 18). Individual and shared interpersonal factors, such as political ideology and family values, inform news media platform choice. Depending on the news site, such personal and group factors become associated with the occurrence and spread of information harms or increase in cognitive resiliency. Gun policy groups such as the Brady Campaign to Prevent Gun Violence and the National Rifle Association operate largely in echo chambers with their supporters while keeping their detractors on the fringe (Merry, 2016).

Applying the SEM toward cognitive security and resiliency in the context of mass shootings provides a theoretical foundation to help underpin the growing amount of computational analysis. Austin *et al.* used combinations of the SEM levels as categorical constructs to explain how Twitter and Instagram users engaged Parkland shooting messages

(2020). By unpacking some of the factors at each SEM level, there is greater support for more granular coding and complex modeling (Janzen, Orr, & Terp, 2022).

Better understanding each SEM level and their intersectionalities can also provide avenues for dealing with future information crises. Challenges in the form of hoax claims and other forms of crisis denial can be intercepted and deflated by organizations and communities likely respected by those sharing information harms. For example, some conspiracy theorists identify strongly with their Christian faith, and so churches at the forefront of individual and community healing in the wake of a shooting can also engage in proactive cognitive resiliency (San Roman *et al.*, 2019). Many churches and nonprofits support immigrant communities; as such, those groups can also help filter information harms before they turn violent or tear families apart in the aftermath of disinformation (Sellnow, Parrish, & Sememas, 2019).

## DISCUSSION

Several common themes emerged across both case studies within and across SEM levels. Below, we describe five of these themes, which represent opportunities to synthesize findings and form avenues for future research.

### Role of social media

The Ebola outbreak was among the first global public health events to demonstrate the potential use of social media platforms such as Twitter to support outbreak surveillance by helping with the identification of health needs, serving as a platform for information dissemination, and providing a means of assessing health education campaigns and other response efforts (Odlum & Yoon, 2018). Research in the aftermath of the epidemic found that the relative volume of Ebola-related Google search queries was strongly correlated with global epidemiological data, but at the country level, this relationship was distorted due to “unbalanced media coverage and the digital divide” (Alicino *et al.*, 2015). Looking at social media worldwide, news stories about the risks of Ebola infections in the U.S. had significantly higher global social media engagement than news stories about Ebola infections in West Africa or science-based information, despite the limited number of cases in the U.S. A study analyzing English-language news articles about Ebola published during a 5-month period in 2014 found that the media sources with the most in-links (defined as “hyperlinks directed at their sites”) were the CDC and WHO, followed by the New York Times and Twitter — highlighting the central role of Twitter as a source of information, both directly (via the platform) and indirectly (via links in news articles) (Roberts *et al.*, 2017). “The digitally networked global public may have influenced the discourse, sentiment, and response to the Ebola epidemic,” the study concluded.

The interaction of social media and mass shootings is similarly complex and of urgent concern to national security and public safety agencies, violence prevention researchers, and information professionals alike. Similar to its role during the Ebola outbreak, social media has been used for good and for malicious purposes surrounding mass shooting incidents. On the one hand, social media data have been used in a variety of ways to better understand how information — and misinformation — about mass shootings is disseminated (Lee, Britt, & Kanthawala, 2022), how people react to misinformation about mass shootings, how emotions influence both the spread of misinformation and its correction (Lee *et al.*, 2021), how mass shooting-related information changes narrative dynamics on social media (Lin & Chung, 2020), how social media serves as both as an indicator and a construction of issue attention (Zhang *et al.*, 2017), and how conspiracy theory narratives develop in the aftermath of mass shootings (Starbird, 2017). In other studies, Natural Language Processing (NLP) methods have been used to uncover linguistic patterns in social media data, showing how discussions about mass shootings on social media contribute to the polarization of the broader discussion online and offline (Demszky *et al.*, 2019). In the aftermath of mass shootings, open-source intelligence researchers have used social media to uncover details about the shooter and possible motives, though this has also led to the false identification of innocent persons as alleged mass shooters (Yurcaba *et al.*, 2022). In terms of malicious uses, social media has been used to circulate terrorist manifestos produced by mass shooters and to radicalize future mass shooters, to intentionally confuse the public with disinformation, engage in trolling, spread hate-based rhetoric, and even promote scams (Robbins, 2022; Ware, 2020).

Taken together, we see that social media is both an asset and a vulnerability during information crises associated with mass shootings and public health emergencies like the Ebola epidemic. The ease of accessibility of false information on social media, as well as the presence of emotionally-laden content, are cognitive risk factors that must be considered when formulating information-related crisis response plans. People who consume more news from social media than traditional media are more likely to believe in conspiracy theories such as those alleging that Ebola is a bioweapon or that mass shootings are false flag events (Klepper, 2022).

## **Role of organizational communication and interpersonal and institutional trust**

As discussed in the case studies above, information crises accompanying public health and public safety emergencies pose a fundamental and onerous challenge to interpersonal and institutional trust. As Lewicki and Brinsfield (2011) have articulated, trust can be conceptualized as a heuristic, or a decisional shortcut. According to their characterization, “Trust and distrust are cognitive frames that help people to organize and interpret new experiences” and “provide a degree of structure and stability to one’s perception of a situation or relationship.” As such, once people deem certain sources to be trustworthy (or not), they tend to maintain these frames until a significant new experience forces them to reevaluate the situation or source.

In general, people tend to trust close interpersonal sources more than any others, which provides an important avenue for communication and information dissemination, but the nature of crises can undermine this trust when rumors and misinformation infiltrate an otherwise trusted information space. Alternatively, people may be more susceptible to misinformation and more likely to believe it when it comes from a trusted interpersonal contact, and since this involves informal channels of communication, it may be more difficult to track the spread of falsehoods when they travel through interpersonal circles. Possibly the greatest challenge associated with information crises accompanying outbreaks and mass shootings is the threat they pose to trust in institutions and information disseminated from institutions. During the information crises surrounding Ebola and mass shootings, trust in institutions was eroded in large part because communication plans broke down — or were never adequately established in the first place — within responding organizations. Cultural considerations were overlooked when communicating about Ebola; meanwhile, most communication about mass shootings either misrepresents or ignores the influence of the obscure internet cultural spaces in which mass shooters are often immersed. Additionally, the nature of crisis situations is such that the facts often change rapidly, which can give the appearance that responders are not competent or are intentionally changing their story — an unfortunate reality that often gives rise to conspiracy theories. In the aftermath of mass shootings, for example, information on the number of victims and fatalities often changes repeatedly as first responders assess the scene; if this information is not treated carefully, the credibility of responding organizations and the media reporting on the situation may be at risk, and once distrust has formed, it may be difficult to reverse. Furthermore, reports from first responders and witnesses may be unreliable due to the effects of trauma on memory and information processing.

While building trust after it has been undermined is a major challenge, the information crises discussed in this paper provide examples of how trust can be established, maintained, and when needed, re-built. During the Ebola crisis, the erosion of trust was associated with violence against health educators trying to disseminate information, and even entire villages barricading themselves in and refusing to accept help. The only way these communities were finally reached was when Red Cross volunteers worked with local politicians and religious leaders, who met with village elders and convinced them to trust the health workers (Desmon & Benham, 2014). In the years since, efforts to rebuild trust in order to establish long-term surveillance infrastructures have focused on building partnerships, addressing inequities, and investing in new tools, technologies, and therapeutics to assist affected communities in future outbreaks (Tambo *et al.*, 2017). Mass media campaigns were also successfully used to rebuild trust in health care facilities (Gurman, Harris, & Sidibé, 2022). In general, however, people trust local news more than national news, and investments in local reporting endeavors are considered key to rebuilding trust in communities affected by disaster-related information crises and conspiracy theories (Misinformation and Trust in Media, 2021). Conducting thorough post-mortems to identify what went wrong in organizations’ crisis response efforts can also be a way of regaining trust and building confidence that the same mistakes won’t be repeated in the future.

## **Role of media coverage**

Public perceptions about crisis events are co-created by members of the public and their primary sources of information, a process that typically involves integrating information from the media with information from interpersonal sources (Dearing & Rogers, 1996). According to the media effects models of agenda setting, framing, and priming, the media plays a crucial role in shaping what the public thinks about (by increasing the salience of certain issues through increased coverage), how the public thinks about those issues (through word choice and narrative framing), and what aspects of those issues the public takes into account and considers most important (by priming audiences and suggesting certain ways of evaluating issues based on specific attributes) (Scheufele & Tewksbury, 2007). Thus, the media serves as a cognitive filter for processing information. During crisis events and other situations involving high uncertainty, people may be even more susceptible to media effects (Kim, 2014), particularly when they have no personal experience with the risk (Berry, Wharf-Higgins, & Naylor, 2007). During the Ebola epidemic and the many mass shootings in recent years, media reports have often resulted in misplaced fears

and concerns due to biased coverage, such as hyper-focusing on the very few contained Ebola cases in the U.S. (rather than the epicenter in West Africa), and devoting excessive coverage to public mass shootings rather than much more common forms of gun violence such as suicide and intimate partner homicide. Since most people lack firsthand experience with Ebola and mass shootings, they rely on media representations to formulate beliefs and attitudes about these events, which may lead to greatly skewed perceptions due to the nature of media coverage.

### **Role of crisis-related data uses, ethical concerns, and biases**

The potential to use social media data and technological resources to detect indicators of disease and/or violence for the purpose of early intervention is a topic of great interest and also of great concern. A variety of techniques have been used for these purposes, including event-based surveillance for outbreak and emerging public health threat detection, web-based real-time surveillance using Google Trends to monitor for symptom-related searches and keywords, agent-based models for infectious disease modeling, and bioinformatics techniques for new pathogen discovery (Christaki, 2015). In one example, using an automated surveillance architecture, Joshi and colleagues (2020) demonstrated the capability to produce early alerts for Ebola outbreaks by aggregating together tweets describing different Ebola-related symptoms. Using historical data to detect symptom-related tweets, they created clusters of tweets based on combinations of two or more symptoms that are characteristic of Ebola, such as fever plus rash, and were able to obtain alert signals in December 2013, which is three months before the outbreak was officially declared. Similar efforts have also been made to predict the occurrence of mass shootings using a combination of data sources including information on demographics, mental illness, community-level measures of social contagion, weapons availability, and more (D'anna, 2020). However, there are significant ethical and privacy concerns associated with this sort of “predictive policing”, and with the notion of accessing geo-located health-related data in areas where Ebola is highly stigmatized. Furthermore, the use of social media and other crowdsourced data for assessing needs, requests for help and resources, injured persons, and other critical data points can reinforce inequalities and power imbalances by elevating certain voices over others, which often means those with access to cell phones, computers, and internet are overrepresented in such datasets (Kraft & Usbeck, 2022).

There are also more general concerns with the use of technologies like artificial intelligence for crisis informatics, including lack of transparency and algorithmic biases, which have the potential to worsen crises by producing inaccurate or skewed output regarding conditions on the ground. Furthermore, there are problems associated with assessing previous crises based on datasets and training data that contain only the information that was made public and survived the crisis. This can lead to survival bias, which describes the cognitive error that occurs when individuals focus on the people or organizations that made it through a crisis and overlook or ignore those that didn't make it. As a result, the data doesn't actually represent the total population affected by the crisis — it only represents those who survived the crisis, but not those who died or stopped sharing information or otherwise lost visibility. Those who survive crises and maintain access to the internet and/or media may be more likely to be healthy, young, male, financially secure, or otherwise different from those who don't survive. Ultimately, this type of selection bias can result in false conclusions and inaccurate information about the crisis based on skewed underlying data. Data from past crises can be a crucial resource for developing plans and protocols to enhance cognitive resilience for future crises, but only if the data are actually representative of the affected population.

### **Role of emotions**

Fear, anger, and sadness were identified as salient emotional processes involved in the response to both mass shootings and the Ebola outbreak. These emotions served as mediating factors that influenced the ways in which individuals processed information, formulated perceptions of the situation, and responded to the crisis. Although emotions are primarily an individual-level factor, their influence was seen across multiple levels of the SEM, influencing processes such as organizational communication, social media dynamics, and even policymaking. Emotions were also outcomes, influenced by other factors across the SEM levels, such as individual emotional reaction to different narratives shared by news media outlets after a mass shooting or source and contagion of an outbreak. The role of emotions will be a focus of future work based on this analysis.

### **CONCLUSION**

Crisis situations like mass shootings and disease outbreaks are among the most complex challenges we face as a nation. Mitigating these vexing problems depends on having accurate information to inform future prevention efforts, early warning systems, interventions, safety protocols, and emergency communication plans. However, accessing and disseminating accurate information in crisis situations is complicated by the technologies and modes of

communication in our modern information-based societies, where any major crisis can also manifest as an information crisis.

In this paper, we described how these dual crises play out among individuals, social groups, communities, organizations, and societies. We also expressed how the interaction of information, people, and technology across the SEM levels ultimately shapes the course of these events, the public's response to them, and the policies that are put into place to deal with similar crises in the future. In a pair of case studies examining information-related dynamics and information-based harms surrounding mass shootings and the Ebola outbreak of 2014-2016, we identified several key common factors associated with cognitive vulnerability and resilience across these diverse crisis scenarios. We then synthesized our findings by describing the five most salient themes that were present in each crisis scenario and across multiple levels of the SEM. These themes included 1) the role of social media; 2) the impact of media coverage; 3) the roles of communication and trust; 4) the use of crisis-related data and associated biases and ethical concerns; and 5) the role of emotions.

During crisis situations, affected individuals and communities — as well as first responders and other individuals and organizations involved in providing aid or emergency services — are faced with the challenge of not only dealing with the initial crisis, but also navigating an information environment that is often characterized by a lack of credible information, an overabundance of unreliable, unhelpful, or uninterpretable information, breakdowns in communication, and at times hostile or malicious efforts to incite chaos, confusion, and even violence. Increased reliance on technological tools and solutions such as predictive algorithms, surveillance systems, and agent-based modeling adds another layer of complexity to this environment. While previous work in this area has provided important insight into how individuals, organizations, and societies respond to public health and safety crises, most of this research has explored only the initial crisis scenario or the associated information crisis (often through the lens of crisis informatics) — but not the co-occurrence and interaction of initial event crisis and the following information crisis. Using the SEM as a framework to characterize the underlying factors that influence cognitive security and vulnerability during crisis situations, our analysis breaks down how the information environment and dynamics surrounding the Ebola outbreak and mass shootings influenced the courses of the crises themselves.

This work represents an important step towards developing the first theory-based conceptual framework of cognitive security and resilience. In future research, we plan to refine this framework by applying a more systematic approach to the identification of cognitive security-related variables at each level of the model, with the goal of producing a framework that can be replicated. In our initial iteration of the SEM for cognitive security and resilience, we identified how it could be used as the theoretical foundation to help generate factors for quantitative analysis. Future work could demonstrate this application within specific use-cases.

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