Information overload, stress, and emergency managerial thinking

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ABSTRACT

We investigate emergency managers' perceptions of information overload from digital sources and examine the relationship of information overload to stress, analytical and intuitive thinking, and managers' critical thinking disposition. We survey 273 county-level emergency managers from 43 states, and conduct semi-structured interviews with 19 emergency managers to investigate these questions. Above and beyond the effects of age, education, experience, and time spent on emergency managerial work, higher levels of perceived information overload from digital sources were significantly associated with higher levels of perceived stress. Holding the same variables constant, higher levels of perceived stress were linked with lower levels of analytical thinking and higher levels of intuitive thinking. Further, managers who reported higher levels of critical thinking disposition reported lower levels of stress. While we cannot imply causation, our qualitative analysis enriches the survey findings by highlighting problems of digital overload in managerial environments.

1. Introduction

Emergency managers routinely make decisions about when, where, and how to respond to an unfolding crisis—from rising floodwaters to a chemical spill—given incomplete information and time pressures. Like many managers, their work environment has evolved to include a greater presence of digital information from new sources, and at a faster pace. The new digital information environment is ripe for stress and information overload, both of which can lead to errors and misjudgments with serious consequences for managing hazards and disasters.

Psychological studies have investigated the cognitive implications of divided attention demanded by information and communication technologies on attention, memory, and learning among the general public [11,54,73,75]. However, there is sparse research on the linkages between perceptions of information overload from digital sources to higher order cognition and information processing styles in public management contexts. We explore whether the ease and speed of information retrieval and transmission, multitasking, fragmentation of routines, divided attention, and the stress and negative affect resulting from information overload characteristic of work in the digital environment is diminishing emergency managers' capacity for certain types of thinking and information processing.

The research reported here is the first phase of a larger research

program on the challenges information overload poses for public managerial thinking. To make progress on understanding the implications of information overload for public managers' work, we take an interdisciplinary approach, synthesizing concepts from psychology and public administration to develop a conceptual model and hypotheses that extends both disciplinary domains. In the context of emergency management, this research: (1) Characterizes the information and communication practices of emergency managers in the US; (2) Examines the linkage between managers' perceived information overload and stress levels; (3) Examines the linkage between managers' perceptions of overload from digital sources and their critical thinking disposition on the one hand, and stress and self-reported information processing styles, specifically analytical-intuitive information processing, on the other. We propose that emergency managers' engagement with digital technologies (the onslaught of emails, social media messages, text messages, news blurbs, tweets, hyperlinks, videos, and pictures) is linked to quicker, emotional, and less reflective thinking. Understanding how emergency managers process the onslaught of digital information adds to a subset of the disaster risk reduction literature on risk interpretation and the challenges posed by new forms of digital communication for making sense of and communicating about disaster risk [21,38,57].

We focus on emergency managers in order to keep the work environment as similar as possible across our respondents and because emergency managers face the potential for digital overload particularly

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acutely. Emergency managers receive an onslaught of digital messages from government agencies, images and reports of concern from the public and private sector, and communication from elected officials sensitive to their political fortunes. Emergency managers balance different perspectives and audiences with digital information in many forms that may be subject to rumor or disinformation (e.g., inaccurate or staged photos on social media). The managers make decisions about how to communicate warning to the public, and they advise government agencies about when and how to prepare, and elected officials about how to address and impending crisis. For example, a county level emergency manager might receive official forecast information and information from river gauges warning of rising waters. The manager would have to decide whether and when to recommend placing sandbags along a riverfront—a potentially costly endeavor—as well as when to recommend evacuation of vulnerable locations. In the face of time pressure managers may not have the time to seek out all of the facts before they decide, but they do have to contend with government officials and the public, each of whom has their own beliefs and sources of information and misinformation.

The emergency manager's potential for information overload given new digital technology and new forms of communication from multiple sources is a particular manifestation of a larger problem: how do managers cope with the increased speed, larger volume, and new sources of information? What is the impact of the new digital environment for critical thinking? How can mangers cope? Some commentators think adapting to the new information environment, by multitasking or better time and information management, is the solution [56]. Others promote the use of smart technologies to better manage the environment [7]. Abandoning the use of digital technology would be as foolhardy as it is impossible. A pragmatic and far-sighted approach would be to understand the limits of technology, determine how to use it appropriately in a given context or circumstance, and learn to better manage information overload and the potential for stress. This research lays the empirical and conceptual foundation for addressing some of these questions by focusing on one type of manager, the emergency manager, for whom the consequences of digital technology are particularly important.

2. Literature review and theoretical foundations

2.1. The emergency management environment

One oft-cited definition describes emergency management as, "the discipline and profession of applying science, technology, planning and management to deal with extreme events that can injure or kill large numbers of people, do extensive damage to property, and disrupt community life" [37; p. xvii]. By the 1990s, the field moved beyond a focus on disaster response to embrace all hazards preparedness, or the idea that managers should take action to reduce vulnerability to a range of disasters [99].

The field has developed the knowledge and credentialing characteristics of a profession over time [72]. There is a steady upward trend in the number of certifications and degrees granted, and a growing network of associations and related bodies of knowledge [43,62,104]. According to a survey of county-level emergency managers published in 2009, 13.5% of emergency managers have postgraduate degrees, 44% have a state certification, and 41% have participated in training from the Federal Emergency Management Agency (FEMA) [65; p.80].

Emergency managers work at all levels of government. In the United States, FEMA and state level agencies are large organizations with responsibility for managing grants, contracts, and planning processes, as well as engaging directly in response. County-level emergency managers, however, more directly manage the planning for disasters, as well as the response. At the county level, emergency managers coordinate activities across government agencies, nonprofits, and businesses to identify hazards, build consensus about how to reduce their effects, plan for the next disaster, and respond and recover when disasters occur [9,

34,93,98]. U.S. county-level emergency managers are "the closest, on-the-ground level of government directly responsible for emergency management" [44; p.366]. Much of their work involves assessing risks and vulnerabilities in a county and in building consensus for how to address them [63; p.173-174; 71]. The particular kind of disaster that emergency managers face depends on their location – the desert is accustomed to droughts, while the coast may be prone to hurricanes. All counties, however, face flood hazards, and most emergency managers have experienced a flood within the last decade [101].

Emergency management tasks are complex, with high levels of uncertainty and the need for coordination across organizations. Managers balance limited time, attention, and resources against a long list of "what ifs," resulting in elevated stress levels [74]. Emergency management work requires higher-level critical thinking including the ability to recognize assumptions and evaluate arguments from multiple perspectives [18,76]. Therefore, it is possible that the increased information flow, stress and complexity of the emergency management job has produced consequences for critical thinking.

The increasing responsibilities of emergency managers for preparing for more kinds of hazards, and for working across organizations and jurisdictions, has been accompanied by an increasing flow of online and offline information [48,49,83]. Some emergency managers report meeting overload [16]. In the online space, emergency managers are increasingly using social media platforms and digital communication technologies from e-mail to texts and video chat to leverage new connections and partnerships [6,39]. These may give rise to new meeting requests, and emergency managers report a lack of sufficient staff to take advantage of social media channels [78]. Hughes and Palen [40; p. 16] interviewed managers and observed that "the speed and reach of social media communications create new demands and expectations by the public for frequent crisis communications. These demands exert pressures on emergency responders to find ways to both receive and filter a great number of incoming communications, and to participate in ongoing social media-based conversations in the public sphere." Greater information flow to and especially from the public increases the public's expectations of emergency managers [88,106].

The increase in information volume and sources of information has given rise to multitasking and the possibility of greater distraction in emergency management work. Citizens may have more outlets for complaints and queries, but agencies may not have more staff to respond [107]. Managers report that "the sheer volume of social data streams generates substantial noise that must be filtered in order to detect meaningful patterns and trends" [50; p. 481]. Some emergency managers report "fear, uncertainty and doubt" when confronted with a bewildering number of new technologies and demands from citizens [61; p. 208].

2.2. Perceived information overload and perceived stress

Classical theories have defined information overload as the experience of feeling burdened by large amounts of information received at a rate too high to process efficiently or use effectively [55,66,91]. Since the 1970s and eighties, the concepts of stimulus, sensory, and information overload have been increasingly important in the study of environmental stress [c.f 28]. Decades of environmental and social psychological research have shown that crowding evokes physiological stress reactions such as increased cardiovascular response, endocrine activity, and skin conductance, reduced task performance, withdrawal, avoidance of social contact, emotional arousal, and aggressive behavior [c.f 5]. Similarly, a series of classic laboratory studies on the immediate and delayed effects of intense, unpredictable, and uncontrollable noise by Glass and Singer [35] has found that unpredictable and uncontrollable noisy conditions were most deleterious to task performance *after* the cessation of the stressor. Changes in interpersonal behavior, such as reduced altruistic behavior, have been found when people were exposed to noisy environmental conditions. For example, persons under stress

from noise do not perceive subtle social cues for distress because they tend to filter out low priority inputs and narrow their attention to the demands of the task at hand [60]. These interpersonal, cognitive, emotional, and physiological effects of environmental stressors have been explained in terms of the *stimulus-overload* hypothesis. That is, when environmental demands (unpredictable and uncontrollable stimuli in addition to the cognitive demands of a task) exceed an individual's information processing capacity and their ability to cope with those demands, stimulus overload ensues [28].

Using an environmental stress paradigm [28,52], Misra and Stokols [68] define *perceived information overload as the feeling of being overwhelmed when environmental demands exceed the perceived capacities to cope with them.* In this research, we conceptualize and measure *perceived information overload* because it is a phenomenon relative to perception, rather than an objective condition of the environment. That is, we are interested in individuals' subjective appraisal of their environment.

Misra and Stokols [68] further distinguished between the sources of overload. Digital sources of information, communication, and stimulation, in contrast to place-based sources, are mediated by networked technologies (Internet-connected) such as smartphones, tablets, laptops, and desktop computers. Examples of digital-based transactions include sending and receiving emails, attachments, text messages, social media posts, processing spam messages, and other information from sources such as podcasts, news websites, and blogs. Additional digital demands include the need to manage multiple information and communication inputs, organize and store information, and maintain devices. Divided attention resulting from managing excessive digital information and communication burdens the working memory and information processing capacities and amplifies distractedness, creating feelings of overload. Indications of digital overload include forgetting to respond to messages because they are lost in the volume of communication, feeling compelled to do multiple things at the same time because of the speed and volume of information, and experiencing strain because of expectations to respond quickly to messages. As a global subjective measure, the *perceived information overload scale measures the extent to which individuals appraise digitally mediated environmental demands as overloading.* Perceived information overload is correlated with, but sufficiently distinct from the perceived stress construct [68].

The effects of digital information overload on managerial stress, organizational productivity and effectiveness have been a topic of research in psychology and business management since the late 1990s [20,24]. In a more recent international survey on workplace productivity across five countries, 59% of white-collar respondents report that the amount of information they have to process has increased significantly. Sixty-two percent report that digital distractions and the inability to sort through the volume of information efficiently negatively affects quality of their work, morale, and ability to focus on their work. Workers report spending nearly half of their day receiving and managing information, rather than using information for their work. Nine out of ten U.S. professionals admit deleting or discarding work information without fully reading it to cope with information overload [53].

While the first generation of information overload studies focused largely on email overload in the workplace, the focus has shifted to online social networking and cell phone use. In separate studies Chen and Lee [13] and Ravindran, Yeow Kuan and Hoe Lian [80] find that information and communication overload combined with decreased self-esteem are key explanatory factors in the connection between social media usage and psychological distress and fatigue. Similarly, in a longitudinal study, perceived information overload from digital sources predicted higher levels of perceived stress and poorer health outcomes in a student population, over and above baseline measures of stress from other sources and other demographic variables [68]. In a study of organizational settings, Mark, Voida and Cardello [59] find that when workers were away from email, they multitasked less frequently, focused on tasks for longer periods, and experienced less stress. Building on this empirical research, we generated the following hypothesis:

Hypothesis 1. Emergency managers who report high levels of perceived information overload from digital-based sources experience high levels of perceived stress.

2.3. Perceived information overload and short-term and long-term cognitive functioning

A recent review of the linkages between digital technology use and cognitive functioning has found a clear negative relationship between digital distractions and attentive capacity in short-term tasks [103]. Experimental studies have found that multi-tasking impedes individuals' ability to distinguish between relevant and irrelevant information [11]; limits information acquisition [82], and leads to poorer retention, learning, and comprehension [79]. Further, digital distractions can result in "resumption errors" – the tendency to commit errors in ongoing tasks after interruptions or switching tasks [10,70].

While there is strong theoretical and empirical evidence of the short-term or immediate cognitive and behavioral consequences of digital distractions and overload, there is relatively less evidence on the long-term (spanning from a few months to several years) impacts on our attentive and information processing capacities. In one important exception, Ophir et al. [73] found a linkage between individuals' media multitasking habits and attentional functioning over the long term. Those who reported engaging in more media multitasking were less able to filter environmental distractions and performed worse on a task-switching activity compared to low multitaskers.

Studies of digital technology use and memory provide insight into the longer-term cognitive impacts of digital technology use. Uncapher, Thieu and Wagner [97] found that chronic and heavy multitaskers performed poorly on working memory tasks regardless of the presence of distractions during task performance. High levels of multitasking were also associated with high attentional impulsivity and susceptibility to task-irrelevant distractions. Similarly, overreliance on digital technologies such as navigation systems have been found to impede spatial memory and cognition [67]. Csikszentmihalyi, Abuhamdeh and Nakamura [19] found a negative relationship between smartphone usage and the capacity to achieve "flow" – "a state of concentration so focused that it amounts to absolute absorption in an activity".

It is possible that there are bidirectional relationships between multitasking, smartphone and social media use and long-term cognitive capacity [4]. have linked the tendency to think more intuitively rather than analytically to higher smartphone reliance. They suggest that intuitive information processors may be more inclined to offload higher order cognition to digital tools.

This study of emergency managers' information processing styles builds on prior empirical work and addresses the limitations of the existing literature in two ways. First, most studies have focused on narrow measures of multitasking, Internet and smartphone use practices, and specific technologies like social media, cell phone, or emails and text messages. We use a more holistic construct of perceived information overload to assess managers' perceptions of digital overload. The perceived information overload construct is based on a Transactional Theory of Stress and Coping perspective [64], wherein information overload occurs when an individual's appraisal of the environmental demands exceeds her/his capacity to cope with those demands. This includes stimuli from a variety of online sources (e.g., text messages, emails, status updates, tweets) and devices (e.g., laptops, smartphones). Importantly, it also may include indirect effects related to organizational settings that compel individuals to work longer hours, at a faster pace, and to process multiple information and communication sources simultaneously.

Second, these studies have examined the impact of multitasking behaviors on certain aspects of lower order cognition, such as working memory and attentive capacity. We want to elaborate this line of research on the long-term cognitive and mental health implications of digital interactions by focusing on information processing modes and

cognitive styles. Assuming that two information processing modes exist, it would be of interest to demonstrate the linkage between perceptions of overload and stress and the relative usage of analytical-intuitive cognitive styles among managers. We are also interested in exploring the linkages between individuals' disposition to critical thinking and information overload and stress.

Finally, we want to focus on the linkages between overload and thinking on one category of public managers, emergency managers, whose digital technology practices, routines, thinking and decision-making styles are important for addressing public problems, but who are not given attention in the psychology or business management literature. We build on a burgeoning public management literature about their practice [39] to study the nature of their work, its potential for stress and overload, and the broad and far-reaching societal impacts of their decisions. Below is a brief overview of the conceptual model employed in this research and the associated hypotheses.

2.4. Perceived information overload, stress, information processing and critical thinking disposition: a conceptual integration

Psychologists have distinguished between the two basic ways of human information processing – thinking and intuition [45], terms which have gone by other names, including deliberative versus intuitive [95]. We use Epstein's [25] cognitive-experiential self theory that posits that information processing occurs in two parallel and interactive systems: analytical and intuitive. The analytical system is assumed to operate primarily at the conscious level. It is intentional, primarily verbal, and relatively affect free. The intuitive system is automatic, preconscious, primarily nonverbal, heuristic, and associated with affect [26]. The degree to which one system dominates depends on individual preferences, the characteristics of the situation, the degree of emotional involvement in the situation or problems, and experience with the situation [2]. In general, intuitive processing is thought to be inappropriate for solving problems that require logical analysis and an understanding of abstract relations.

A long tradition of reasoning research has demonstrated that human cognition is miserly in nature – it favors effortless intuitive processing over cognitively demanding analytical thinking [3,29,46,47,86,87,94]. This feature of human cognition, when combined with contemporary digital environments in which people are readily able and encouraged to offload certain aspects of their cognition on to intelligent tools such as smartphones and AI systems [14,81], is fertile for reliance on quicker, less reflective, and intuitive information processing.

As data and information continues to proliferate and intelligent machines become an indispensable part of our ecology, managers are compelled to work in fast paced, quickly changing environments, replete with distractions that encourage multitasking and divided attention and limit opportunities and inclination for effortful cognitive processing. Cognition, defined as the ability to recognize emerging risks and act on them, has been found to be central to effective emergency management [17]. Thus, we generate the following hypotheses:

Hypothesis 2. Emergency managers reporting higher levels of perceived information overload will report higher levels of intuitive thinking and lower levels of analytical thinking.

Hypothesis 3. Emergency managers reporting higher levels of perceived stress will report higher levels of intuitive thinking and lower levels of analytical thinking.

Hypothesis 4. Perceived stress mediates the relationship between perceived information overload and analytical-intuitive thinking. That is, high level of perceived information overload will lead to high levels of perceived stress, which will in turn lead emergency managers to report high levels of intuitive thinking and low levels of analytical thinking.

2.5. Critical thinking disposition, information overload, and stress

We were also interested in the relationship between information overload and another higher order thinking style relevant to managerial decisions and closely related to analytical thinking—critical thinking disposition. Distinct from information processing modes, dispositions examine the manner in which individuals approach a task [51], or the tendency to do something [23]. Critical thinking disposition is an intrapersonal trait defined as a combination of intellectual attitudes and mental and behavioral tendencies describing the way an individual reasons, argues and make decisions [30,77]. The literature supports the existence of distinct but related dispositional and cognitive dimensions of critical thinking [e.g., 51, 58, 92, 102].

Critical thinking disposition is associated with stronger academic performance, deep learning, good professional practice and professional expertise, lower anxiety, stronger ego-resilience and overcoming cognitive bias in reasoning [22,30,31]. For the purposes of this research, we use Fasko's [32; p. 8] definition, "the propensity and skills to engage in activity and 'mental activity' with reflective skepticism focused on deciding what to believe or do …" Both critical openness (the tendency to be open to new ideas, critically evaluate them, and modify one's thinking in light of the evidence) and reflective skepticism (the tendency to learn from the past and question the evidence) are required for critical thinking disposition [85].

Very little research has examined the linkages between critical thinking disposition and affective dimensions (see Suliman and Halabi [90] for an exception). Given that individuals with higher disposition to critical thinking are likely to engage in metacognitive reflection and revise their beliefs and behaviors, they may be better able to cope with digital information overload. They are likely to be strategic and intellectually careful, better able to focus their attention, handle complexity, persist in the face of difficulties, and have higher tolerance of ambiguity [85]. We propose the following exploratory hypotheses:

Hypothesis 5. Managers with higher levels of critical thinking disposition experience lower levels of overload and stress.

The conceptual model (Fig. 1) shows the proposed relationships between the constructs of interest in this research based on the preceding review of the theory and empirical research. We propose that high perceived information overload from digital sources will predict high perceived stress, low levels of analytical thinking, and high propensity for intuitive information processing. Furthermore, high perceived stress will predict lowered capacity of analytical thinking and higher inclination to rely on intuitive thinking styles. Critical thinking disposition, as an intrapersonal state, is an antecedent factor in this conceptual framework. We posit that individuals disposed to critical thinking will appraise environmental demands and life stressors as less overwhelming, uncontrollable, and unpredictable. Specifically, their disposition to critical thinking can enable them to contemplate and reevaluate their experiences and behaviors, think about the wider implications of their actions, and about whether they can change their actions for the better. Therefore, we expect that individuals reporting high levels of critical thinking disposition will experience lower levels of stress and overload.

3. Method

3.1. Sample and data collection procedure

We use an explanatory mixed method research design to examine these hypotheses. First, we use a cross-sectional correlational research design beginning with a survey of county level emergency managers. A total of 273 county-level emergency managers participated in the survey. As shown in Table 1, the sample was predominantly male (79.6%) and white (88.4%), which reflects the profession as a whole. County-level emergency managers are largely white, 45 years or older, and
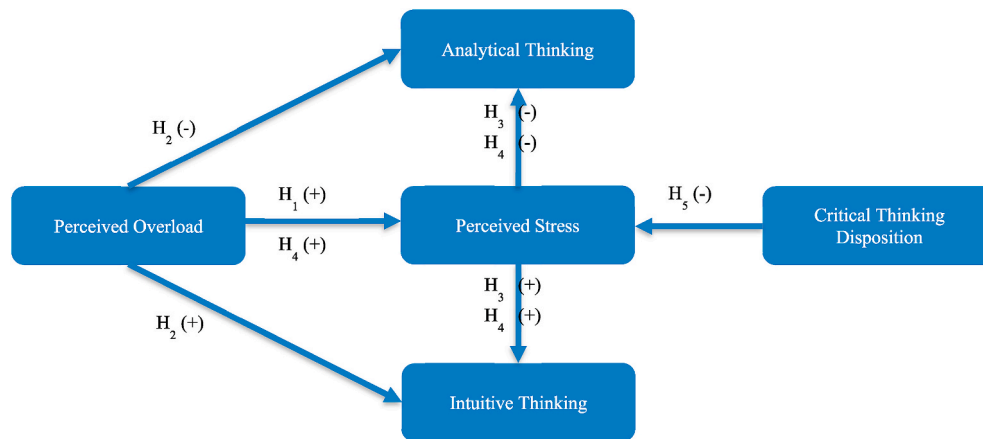
Fig. 1. Conceptual model linking perceived overload, perceived stress, analytical and intuitive thinking, and critical thinking disposition.

Table 1
Demographic characteristics of emergency managers (n = 273).

	n (%)[a]
Age in years (M [SD])	54.9 (9.5)
Experience in years (M [SD])	21.4 (11.9)
Gender	
Male	214 (79.6)
Female	54 (20.1)
Other	1 (0.4)
Total	269
Race	
White	237 (88.4)
African American/Black	2 (0.8)
Hispanic	4 (1.5)
Asian	1 (0.4)
American Indian	4 (1.5)
Pacific Islander	0 (0)
Multi-Racial	7 (2.6)
Decline to Specify	13 (4.9)
Total	268
Veteran	
Yes	57 (21.2)
No	212 (78.8)
Total	269
Education	
Less than high school	0 (0)
High school or equivalent	13 (4.8)
Some college	115 (42.8)
Bachelor's degree	83 (30.9)
Graduate or professional degree	58 (21.6)
Total	269

[a] Unless otherwise noted.

have more than 10 years of work experience [41,44,100,101]. The mean age of participants was 54.87 years ($SD = 9.51$), and the mean level of experience in the field of emergency management was 21.42 years ($SD = 11.89$). 95.2% of the sample indicated some college education with 52.4% having obtained at least a bachelor's degree. The survey yielded a response rate of 11.6%, with responses coming from 43 out of the 50 states. We provide more details of the sampling frame, sampling strategies, response rate calculations and comparisons, and sample characteristics in the Methods Appendix (Appendix A). In order to explain the survey results, we conducted interviews of 19 emergency managers representing 18 counties. Details of the interview sample and procedures are in Appendix A. First, we describe the quantitative measures and results. This is followed by a detailed explanation of each set of quantitative findings through the interviews.

3.2. Measures

The survey asked participants to complete the following scales (complete scales used in this study are provided in Appendix B): (1) A modified 4-item version of Misra and Stokols' [68] Perceived Digital Information Overload Scale ($\alpha = 0.73$, $M = 3.36$, $SD = 0.67$); (2) A modified 10-item version of Cohen, Kamarck and Mermelstein's [15] Perceived Stress Scale (PSS) ($\alpha = 0.85$, $M = 2.37$, $SD = 0.53$); (3) Epstein, Pacini, Denes-Raj and Heier's [27] 5-point Likert-type Rational-Experiential Inventory Scale (REI) focuses on understanding differences in analytical and intuitive information processing using two independent sub-scales. The Faith in Intuition Sub-Scale provides a measure of intuitive-experiential information processing ($\alpha = 0.83$, $M = 3.64$, $SD = 0.51$), while the Need for Cognition Sub-Scale provides a measure of analytical-rational information processing ($\alpha = 0.76$, $M = 3.67$, $SD = 0.54$); and (4) Sosu's [85] 5-point Likert-type Critical Thinking Disposition Scale (CTDS) ($\alpha = 0.80$, $M = 4.18$, $SD = 0.35$) is an 11-item instrument that measures two dimensions – 'Critical Openness' ($\alpha = 0.73$, $M = 4.13$, $SD = 0.38$) and 'Reflective Skepticism' ($\alpha = 0.72$, $M = 4.27$, $SD = 0.42$). Sosu [85] finds that both Critical Openness and Reflective Skepticism are required for the critical thinking disposition. In addition to the scales and measures of thinking and information processing styles, participants were asked to record the number of hours they spent per week engaging in specific forms of digital and non-digital information and communication (details in Appendix B).

4. Results

4.1. Descriptive statistics

In addition to the demographic statistics, Table 2 reports the percentage of time spent on emergency management work, and the time since the last serious emergency and Table 3 presents a breakdown of hours spent per week on different forms of digital and non-digital forms of information and communication. On average, emergency managers spend more time with digital forms of communication ($M = 49.9$ h, $SD = 26.7$) than non-digital ($M = 16.6$ h, $SD = 11.0$) per week. Table 4 provides the correlation matrix for the variables of interest in this study.

Table 2

Percent of time spent on emergency management work, and time since last serious emergency.

	n (%)
Percent of Time on Emergency Management Work	
0%	1 (0.4)
1%–20%	37 (13.8)
21%–40%	30 (11.2)
41%–60%	47 (17.5)
61%–80%	39 (14.5)
81%–100%	115 (42.8)
Total	269
Time Since Last Serious Emergency	
Within the last year	98 (36.6)
Within the last 5 years	108 (40.3)
Within the last 10 years	46 (17.2)
Within the last 15 years	6 (2.2)
More than 15 years ago	10 (3.7)
Total	268

Table 3

Hours spent per week on digital and non-digital based communication.

	M(SD)
Digital Based Communication	49.9 (26.7)
Email	10.5 (7.8)
Music	3.5 (6.8)
Non-Music Audio	2.0 (4.8)
Online	5.3 (5.9)
Online Videos	2.1 (3.2)
PC Applications	12.0 (9.2)
Social Media	5.6 (6.2)
Text	4.4 (5.2)
Video Games	0.4 (1.4)
Web	4.3 (4.5)
Non-Digital Based Communication	16.6 (11.0)
Phone Calls	7.3 (6.8)
Print	2.4 (3.1)
Television	6.9 (6.7)

4.2. Hierarchical regressions[1]

4.2.1 Digital Information Overload and Perceived Stress: As presented in Table 5, perceived information overload was found to be significantly and positively linked with perceived stress levels, over and above the effect of age, education, and time spent on emergency management work ($\beta = 0.24$, $t\,(247) = 3.80$, $p < .01$). The overall model was significant, $F\,(4, 248) = 5.96$, $p < .01$. That is, emergency managers who reported higher levels of perceived digital overload also reported significantly higher stress levels. This finding aligns with earlier research on the negative impacts of digital overload on stress and health.

4.2.2 Perceived Digital Information Overload, Perceived Stress and Analytical and Intuitive Thinking: Contrary to our hypotheses, we did not find a significant negative relationship between perceived digital overload and analytical thinking. However, over and above the effect of age, education, experience and time spent on emergency manager work, information overload from digital sources was marginally and positively associated with an intuitive thinking style ($\beta = .12$, $t\,(247) = 1.86$, $p = .067$). The overall model was not significant, however.

As hypothesized, over and above the effect of age, education, experience and time spent on emergency manager work, perceived stress was significantly and negatively associated with Need for Cognition ($\beta = -0.17$, $t\,(245) = -2.71$, $p < .01$), as shown in Table 6. The overall model was significant, $F\,(5, 246) = 5.88$, $p < .01$. This indicates that, while holding other variables constant, higher levels of perceived stress are associated with lower levels of analytical thinking capacity. The same model was fitted to the Faith in Intuition scale, but contrary to our hypothesis, we found a significant negative relationship between perceived stress levels and faith in intuition ($\beta = -.13$, $t\,(245) = -2.05$, $p < .05$). The overall model, however, was insignificant. That is, higher levels of perceived stress were significantly associated with lower intuitive thinking capacity.

4.2.3 Critical Thinking Disposition, Perceived Digital Information Overload, and Perceived Stress: We did not find a significant linkage between managers' overall critical thinking disposition and perceived information overload levels, against our predictions. However, above and beyond the effects of age, education, experience, time spent on emergency management work, and time since the last serious emergency incident, Critical Thinking Disposition had a significant negative relationship with perceived stress levels ($\beta = -0.18$, $t\,(243) = -2.75$, $p < .01$), as shown in Table 7. The overall model was significant, $F\,(6, 244) = 2.85$, $p < .05$. As hypothesized, emergency managers who are highly disposed to thinking critically experience lower levels of stress.

5. Conclusion and discussion

5.1. Overload and information processing style

This study presents evidence of some of the unfavorable implications of digital-based information overload and stress on long-term cognitive processes in a real world public managerial setting. County-level emergency managers in the US spend the majority of their time using a variety of digital-based information and communication technologies. Managers who experience high levels of digital information overload (e. g., feeling overwhelmed with too many digital information and communication channels, pressure to manage several electronic inputs at the same time, pressure to respond to messages quickly) also experience high levels of psychological stress. This finding extends prior research on the physical and mental health implications of digital technology use and multitasking to emergency managers.

Qualitative interviews provided further insight into this finding, with managers seeing technology as "a blessing and a curse," or "a double-edged sword." While technology has given them access to more real-time information, it is not always beneficial. One emergency manager noted that "when you're in an austere environment where you've got to make a rapid decision … having file rooms of information is not necessarily going to help you." The same manager stated that in the digital age, the "time to solution expectation" has intensified among the public and public officials without a corresponding increase in the speed at which he can process information. Another emergency manager described receiving inquiries directly from citizens during weather emergencies before he was able to make a general announcement to the public.

The public's increasing expectations about the speed of information from public officials is further complicated by the proliferation of information sources and channels. Emergency managers can no longer rely on traditional means of communication such as press releases. Citizens and public officials demand information instantaneously through the electronic platforms that they use. Social media is one of the main drivers of demand. A manager from the northeast United States

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[1] Gender was initially included as a covariate for each model reported here but was shown to be highly insignificant in each model, so it was removed. We used hierarchical regression as a model comparison technique to determine whether our independent variables of interest explained a statistically significant amount of variance in our dependent variable, *after accounting for all other variables.* Our interest was to determine whether newly added variables show a significant improvement in the proportion of explained variance in dependent variable by the model. Using this technique, we built several regression models by adding variables to a previous model at each step. The first step included control variables (age, gender, education), the second step included any known important variables in this line of research, and finally step 3 included the independent variable of interest [33].

Table 4
Correlations between key study variables.

Variables	Information Overload	Perceived Stress	Critical Thinking	Faith In Intuition	Need For Cognition	Age	Education	Experience	PerctEM	Serious
Information Overload	1									
Perceived Stress	0.25**	1								
Critical Thinking	0.11	−0.16*	1							
Faith In Intuition	0.10	−0.12*	0.04	1						
Need For Cognition	−0.01	−0.16*	0.5**	−0.04	1					
Age	−0.13*	−0.18**	−0.05	−0.07	−0.03	1				
Education	0.07	0.02	0.13*	−0.03	0.24**	−0.19**	1			
Experience	0.02	−0.06	0.16**	0.00	0.03	0.35**	−0.15*	1		
PerctEM	0.22**	0.03	0.06	−0.01	0.06	−0.12*	−0.01	−0.13*	1	
Serious	−0.08	0.00	−0.07	−0.01	−0.15*	0.07	−0.06	0.00	−0.28**	1

*$p < .05$.
**$p < .01$.
PerctEM = Percentage of time spent on emergency manager work; Serious = Amount of time since last serious emergency.

Table 5
Multiple regression analysis between information overload and perceived stress ($n = 253$).

	Perceived Stress	
	β	Std. β
Age	−0.009**	−0.167
Education	−0.021	−0.034
PerctEM	−0.017	−0.047
Information Overload	0.187**	0.237
R^2	0.088**	
Adjusted R^2	0.073	

*$p < .05$.
**$p < .01$.
PerctEM = Percentage of time spent on emergency manager work.

described the public's expectation that information be posted on social media at all times, even at 3:00 a.m. A second manager noted a need to "respond at the speed of social media," with a third describing how "the public's expectations have outpaced our implementation of technology."

One of the most stressful aspects of the new digital landscape is the increased possibility for sharing incorrect information. Emergency managers reported feeling overwhelmed at the task of verifying information. Many reported diverting time and resources to managing social media and dispelling the rumors that it fosters. Others note that they have not put more time into combatting rumors and incorrect information because of the time commitment, with one manager saying "we're already over-committed and understaffed, so it's just another thing that requires more of our time." Some managers went as far as to say, "social media can kill ya if you're not ahead of the game and watching it," and "you can't stay ahead of social media … it's something that you may never get your arms wrapped around, but you have to work with it." Conversely, one emergency manager from a rural New England county did not feel pressure from social media. She stated that no one had ever asked why information was not on their Facebook page and that she believed Facebook was not a source the community used for emergency information. Low interest in using social media use in some counties indicates that the public ultimately drives managers' attention to social media. Other research shows that population size is positively associated with stages of e-government development [42].

Due to the constant flow and demand for information, a common theme among managers is an inability to disconnect from the information and never having a chance to turn it off. One manager of a small urban county described how his work is now "24/7." He identified the around the clock pressures as a health and safety challenge, which prompted him to provide clinical social work and psychological services to his staff.

Beyond the impact on stress and workload, information overload affects thinking. Higher levels of digital overload were linked, at a marginally significant level, to greater reliance on intuition – that is, the tendency to depend on fast, superficial, and automatic information processing. It is possible that experiencing high levels of information overload taxes managers' attentive capacities and diminishes cognitive resources available for more effortful and deliberative thinking. While we did not find a significant relationship between higher levels of information overload and lower analytical information processing, but the data showed the expected negative relationship between the two variables.

Interviews revealed a pattern of adapting to the increased speed and volume of information. Many emergency managers in our sample expressed a need to work faster and to prioritize information. An emergency manager from a large rural county noted that "the speed in which we demand things has encouraged us to work faster than we would have been before," while also stating, "you can't usually skip too terribly much [information], but I'll certainly find myself glancing at something and most quickly assess that it's not an urgent [situation] right away for instance." A second emergency manager from a small, sparsely populated western county expressed being overwhelmed during emergencies and escalating incidents creating the need to "prioritize and … take care of what I have to take care of …" before returning to other tasks such as media communications.

Other emergency managers chose to triage information. One emergency manager from a major east coast metropolitan area described a strategy of pre-identifying the data necessary to make decisions and learning to "ignore or at least not spend so much time on the other pieces." Prioritization and triage can be costly during emergencies if a manager focuses on only one or two streams of information and ignores other potentially good sources "because we don't have the capacity to use those as well." In some cases, emergency managers try to use technology tools such as Hootsuite to aggregate information and automate its analysis. In the future, other technology may go as far as assessing a situation and suggesting what resources to deploy.

One explanation for the lack of statistical significance could be the size of our sample. We expect that a larger sample size would reveal significant results. Another explanation could be that the limited 4-item digital-based information overload scale was not able to capture emergency managers' experiences with digital technologies. It is possible that the composite measure of perceived information overload from both digital-based and place-based sources used in earlier studies would have captured the intrinsic linkages between the real and virtual environments with regard to how these technologies are experienced. Technologies are experienced in the context of the design and structure of

Table 6
Multiple regression analysis between perceived stress and need for cognition (*n* = 252).

	Need For Cognition	
	β	Std. β
Age	0.000	0.000
Education	0.174**	0.275
Experience	0.003	0.056
PerctEM	0.033	0.091
Perceived Stress	−0.171**	−0.167
R^2	0.107**	
Adjusted R^2	0.089	

*p < .05.
**p < .01.
PerctEM = Percentage of time spent on emergency manager work.

Table 7
Multiple regression analysis between critical thinking disposition and perceived stress (*n* = 251).

	Perceived Stress	
	β	Std. β
Age	−0.012**	−0.215
Education	0.002	0.004
Experience	0.002	0.051
PerctEM	0.006	0.017
Serious	0.007	0.013
Critical Thinking	−0.268**	−0.177
R^2	0.066*	
Adjusted R^2	0.043	

*p < .05.
**p < .01.
PerctEM = Percentage of time spent on emergency manager work; Serious = Amount of time since last serious emergency.

physical, social, and organizational environment, and interviews indicate that social media is a prominent digital-based stressor. We decided to use the shortest possible scales in this study because we were sensitive to emergency managers' heavy workload and time pressures. We did not want to burden them with long questionnaires, especially because of the potential for reactivity (a threat to internal validity) to a survey about information overload and stress.

Yet another explanation could be that professional managers are reluctant to admit that they are experiencing digital and work-related stressors. Almost by definition, emergency and crisis managers are expected to remain cool under fire. It is possible that individuals who tend to rely more on intuitive thinking also depend on digital technologies more and therefore experience more information overload. It is also possible that the relationship between information overload and thinking and information processing styles is bidirectional — higher information overload leads to a higher tendency to rely on intuitive thinking and therefore results in higher information overload. We cannot rule out these alternative hypotheses in the present study, but these questions are worthy of empirical exploration in future research.

5.2. Stress, analytical thinking, and critical thinking disposition

Experiencing high levels of stress is associated with lower capacity for analytical thinking (e.g., the tendency to not like to think too much or too deeply) for the emergency managers in our sample. Possibly, stress taxes the working memory and reduces managers' ability to engage in effortful analytical thinking. As described previously, the reverse relationship is also plausible. That is, managers who report lower levels of analytical thinking capacity experience higher levels of stress because they are less able, cognitively, to cope with the stressors in their life. We are not able to rule reverse causation through the present

research design.

Contrary to our expectations, experiencing high levels of stress is significantly linked to lower levels of intuitive thinking. This result is surprising and does not have a straightforward theoretical explanation. It could mean that experiencing stress not only has the potential to impede analytical thinking but also intuitive thinking capacity. It is possible that some affective states, but not others, result in higher reliance on intuitive processing. Further, from a philosophical perspective, intuition is a source of creativity and wisdom. Intuiting involves recognizing patterns and making holistic associations, rather than making connections through logical thinking [46,84]. Thus, it is possible that the negative affect resulting from stress results in lowered intuitive thinking capacity. Yet another explanation is that respondents who perceive high levels of stress are more reflective and less likely to rely on the quick judgments of intuition – these respondents may be more prone to perceive stress because they are less likely to make quick judgments and move on to the next stimulus in the environment. These results raise new and intriguing questions for exploration in future research.

While we did not find a significant relationship between critical thinking disposition and perceived information overload, managers with higher critical thinking disposition experience lower stress. It is possible that these managers are better able to buffer the negative impacts of life stressors because they can step back and reflect on the bigger picture, take time contemplate their experiences and behaviors and re-evaluate them, think about the wider implications of their actions, and about whether they can change their actions for the better. These cognitive and behavioral tendencies may allow managers to better deal with life and work stressors.

In our interviews, emergency managers noted the importance of stress management and coping skills, which often manifest as actions exhibiting high levels of critical thinking. The managers showed an ability to learn from past events that influenced future actions. One manager stated, "We always spend a lot of time after events trying to make it better for the next time, so each time tends to be better than the last time, but it's never as good as you'd like it to be ideally." The same manager noted, "I spend 360 days trying to get the data that's going to help me the five days when I actually have to make decisions based on it." A second emergency manager described how he approached decisions before a large anticipated event deliberately. He would meet in person with decision makers to determine what information was important to them and how they wanted to receive it. The direct discussions limited guesswork and the possibility of making ill-informed decisions during stressful events. Finally, a third emergency manager described the need to slow down during emergency incidents to analyze and question the information he received. This strategy was not natural but learned through experience, after critically assessing the way that technology had negatively affected his departments' actions. The manager reported that critically assessing data was important to his department's successful operation.

5.3. Limitations, contributions, and future research directions

We acknowledge a number of limitations in this study. First, our study has a low response rate. Although our response rate is comparable to most other studies of emergency managers, included respondents from 43 out 50 states, and had comparable representation from urban and rural counties, we cannot be certain of the representativeness of the sample and hence make no claims about the generalizability of our findings. Nevertheless, such concerns are typical in the study of populations of experienced professionals. We do not have a reason to suspect non-response bias or sampling bias, however. We did not find evidence that highly overloaded or stressed managers were more likely to respond to our survey.

Second, the Adjusted R-squared values of our models are low. At the same time, our predictor variables are highly significant. Fitted line plots revealed high-variability data with a significant trend. Since our

predictor variables were found to be related to the outcome variables by more than chance, this indicates that the predictor variables still provide useful information about the response variable even though data points fall further from the regression line. Further, low R-squared values are problematic when we are looking for precise predictions [8,33]. The purpose of this research was not to precisely predict the effect of overload on stress and thinking, but to test theoretically specified relationships among our variables of interest.

Third, we measure the effects of perceived overload and stress on emergency management thinking, but we do not measure the effects on performance. We do, however, compare our quantitative survey results with qualitative interviews in which emergency managers report challenges that digital technologies pose for their work.

Limitations notwithstanding, this study makes a number of contributions. First, it addresses a sparsely researched area of digital environmental stressors in the emergency managerial field. It develops a conceptual model linking critical thinking disposition, digital overload, and stress, with certain types of thinking and information processing which can be applied to other public management settings. Second, it characterizes the information technology use patterns and routines of emergency managers and finds evidence of the potential consequences of information overload on long-term cognition and psychological well-being, elaborating earlier research on the short-term cognitive consequences of overload in experimental settings.

The study reported here is a first step in a larger research program on the cognitive impacts of digital overload in public managerial contexts. In an in depth qualitative study [c.f. 69], we address some of the broader structural and organizational transformations caused by digital technologies, the impacts of digitization on the nature of emergency managerial work, and the cognitive, affective, and behavioral implications of these transformative changes.

In terms of next steps, the findings of this mixed method study should be replicated in other public management settings and populations. The next phase of this research program is to develop natural or quasi-experiments that causally link digital information overload to specific aspects of public managerial work. Future research also needs to conceptualize and empirically investigate the cognitive and affective implications of incomplete, false or incorrect, and conflicting digital information on managerial thinking dispositions. Finally, we need longitudinal studies that examine the long-term impacts of digital overload and stress on public managerial thinking and decision-making.

This body of research has the potential to guide efforts to improve managerial thinking and practice through structuring the work environment to buffer the pressures of the digital age. For example, some emergency management tasks, such as developing hazard mitigation plans across agencies and communities, require deep, analytical thinking, tradeoffs among values, and calculation of uncertainty and risk. At the same time, the level of perceived overload and stress could vary by person as well as by organization. The effect of short and longer-term individual and organizational level interventions that limit stress and the potential for overload in situations that require analytic thinking, such as distraction-free planning periods, scheduled time for face-to-face communication, and artificial intelligence systems that triage the most important decisions for emergency and crisis managers, is an area for future research. Similarly, in situations where there is a high potential for stress, the design and implementation of training programs in stress management, reflective thinking, and mindfulness for public managers is another area for research. Training in other environments has been shown to be effective in reducing stress and increasing long-term concentration [1,36,105].

In sum, emergency management has benefited from the introduction of digital technologies in a host of ways. Managers now have more real time situational awareness and a greater ability to communicate across government and nongovernmental organizations and with the public. We believe the future of effective emergency management lies in learning how to co-evolve with technology to benefit human cognition

and decision-making – not in avoiding it. If the potential for overload and stress from digital technologies pose a problem, perhaps a combination of organizational, human, and digital remedies can help. As an initial step toward those goals, the present research contributes a conceptual model that links perceived information overload from digital sources to stress and long term cognitive functioning; and an empirical foundation for efforts to address some of the negative consequences of information overload and stress.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijdrr.2020.101762.

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