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Editorial Board

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COVID-19 and Its Impact on the Midwest United States

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Abstract

The COVID-19 pandemic has impacted many lives and livelihoods all over the world. We have looked at some infection and death rates statistics based on population globally, in the US, and in the Midwest. Unfortunately, as of December 21, 2021, all states in the Midwest region had higher infection rate than the US as a whole. The death rate, fortunately, in many states in the Midwest was lower than the US death rate as a whole. We have identified some research questions (and of course there are many more) that IS/T colleagues in the Midwest and elsewhere can pursue.

Keywords: COVID-19, Midwest US implications

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1. Introduction

Since March 2020, the world has been dealing with the COVID-19 pandemic. The impact on our lives has been staggering. As of December 21, 2021, globally there have been over 275 million known cases of COVID-19, and the death toll exceeds 5.36 million. In the U.S., more than 51 million people have contracted COVID-19, and more than 808,757 have died (coronavirus.jhu.edu/map.html). The world and US population on this date was listed as more than 7.866 billion and 332 million, respectively (US Census Bureau). Hence, the percentage of infection and death rates based on population globally are 3.49 and 0.07, respectively. For the US, similar percentages are 15.36 and 0.24, respectively. We are currently in the midst of a fifth wave of contagion and spread, due to the Omicron variant, although, the implications of this new variant are not fully understood yet. Table 1 below depicts similar statistics about the States in the Midwest as of December 21, 2021. These rates are based on each states' number of infections, death, and population size.

Table 1. Midwest States' Infection and Death Rates as of December 21, 2021

State	No. of Cases	No. of Death	Population	% Infection Rate	% Death Rate
Illinois	1,975,515	29,661	12,801,989	15.43131	0.231691
Indiana	1,192,448	18,489	6,785,528	17.5734	0.272477
Iowa	557,029	7680	3,271,616	17.02611	0.234746
Kansas	501,226	6920	2,937,880	17.06081	0.235544
Michigan	1,629,362	27,901	10,077,331	16.16859	0.276869
Minnesota	982,664	10,280	5,706,494	17.2201	0.180146
Missouri	968,560	15,871	6,154,913	15.73637	0.257859
Nebraska	327,858	3,298	1,961,504	16.71462	0.168136
North Dakota	169,545	2,023	779,094	21.76182	0.259661
Ohio	1,855,222	28,028	11,799,448	15.72296	0.237537
South Dakota	174,021	2,438	886,667	19.62642	0.274962
Wisconsin	1,061,618	10,763	5,893,718	18.0127	0.182618

Sources: coronavirus.jhu.edu/map.html
Infoplease.com/us/states/state-population-by-rank

As Table 1 shows, unfortunately, all states in the Midwest region have higher infection rate than the US as a whole. The death rate, fortunately, in many states in the Midwest is lower than the US death rate as a whole. Although it is difficult to predict the long-term implications of COVID-19 for the Midwest, it is vital to plan ahead for different scenarios over the next few years and beyond.

The higher infection rates in the Midwest potentially have to do with lower vaccination rates. Even among college students, some vaccine hesitancy remains. A study by Wotring et al. (2021), based on a survey of 1,600 students in a Midwest university, indicates that only half of them were vaccinated. Among those who were not vaccinated, about 49% indicated that they do not intend to get vaccinated. About 78% of those not vaccinated feared potential side effects, and about 72% indicated that they do not trust the vaccine. The authors suggest that "targeted messaging" could potentially be effective in reducing or eliminating vaccination hesitancy.

The pandemic has already impacted how we educate individuals, regardless of their age. The lack of technology availability and access to high-speed Internet, in particular, in the rural areas of the Midwest is creating additional burden on low income and indigenous communities. This further adds to the existing equity related problems that already exist in some school districts, colleges, and universities in the Midwest region. The lack of equity is not limited to the Midwest or even the United States. Rather, it seems that it is apparent in other parts of the world. In a study about students in Germany, Händel et al. (2020) found that there were two groups of students that significantly differed in terms of their

readiness for online learning: Those who do have access to the needed technology and have prior experience with e-learning and those who do not. To avoid an additional equity gap as a result of the pandemic and moving to the online mode of course delivery, there is a significant need for supporting school districts and low-income college and university students to make sure technology and access to high speed Internet is available to all students regardless of their location and family income level.

There is also the need to look at the implications for faculty members who were not adequately familiar with and/or prepared for the online mode of course delivery. We should examine their perception, in particular, due to the fact that in many institutions, the shift to online mode of delivery occurred literally in a matter of days. Cameron-Standerford et al. (2020) looked at the perception of faculty members in a mid-sized rural Midwestern university. Among the interesting results of this study is that the authors asked respondents to identify ten words that described their experience of moving to online mode of course delivery. With the frequency of from fifteen to six, these are the words that were used: "challenging, concern, anxious, stressful, relieved, overwhelmed, hopeful, confident, uncertain, and flexible" (p. 6).

A careful review of the above ten words clearly indicates that the respondents had a varying degree of familiarity and preparation to offer online courses. This and similar studies should serve as a warning for higher education institutions to be more prepared for these kinds of emergencies by providing appropriate levels of faculty development as well as adequate access to various educational technologies for faculty and students.

The social distancing and isolation experienced during the pandemic, unfortunately, will potentially have long term implications for the mental health of children and potentially even adults. Moriarty, Bourbeau, Fontana, McNamara, and Pereira da Silva (2021) surveyed 868 college students in a public university in the Midwest and reported that reduced exercise and sleep during the COVID-19 pandemic significantly predicted the levels of stress. Browning et al. (2021), in a study of seven universities in the United States, concluded that not recognizing and addressing mental health challenges caused by the pandemic could potentially have long-term impact on the mental health and education of students. These and similar studies may be useful for universities to develop health-promotion strategies.

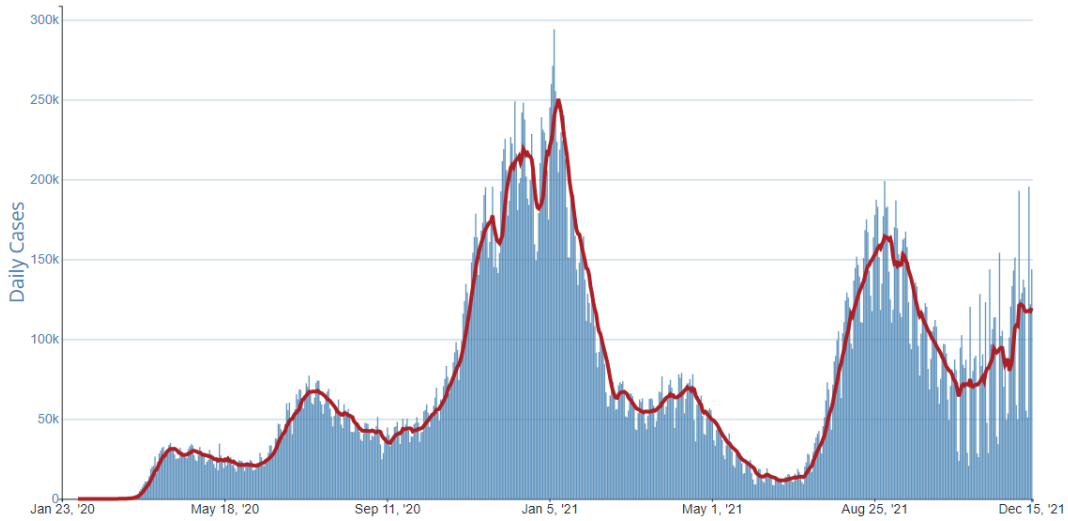
Many people believe that we will never vanquish the virus, and that it will become a part of the landscape. A recent article in the *New York Times* concluded that "Eventually, as viral evolution slows down and our immune systems catch up, we will reach an uneasy equilibrium with the virus, scientists predict. We will never extinguish it, but it will smolder rather than rage (Anthes, 2021)." If true, the question becomes how do we live with it, rather than how do we return to 2019.

For information systems academics, there are many opportunities for research regarding COVID-19 that is not only interesting but that may also have important practical impacts. While this list is by no means comprehensive, there are some research areas for which we can use our particular skill sets to investigate. These include topics related to medical equipment, patient healthcare records, pandemic-related statistics, healthcare informatics, in general, and data visualization, in particular, use of Zoom-like platforms for research collaboration and teaching, and the use of social media to disseminate both information and disinformation about the virus and treatment. Examples of research in each area follow.

2. Health Related Data Collection and Visualization

The U.S. Centers for Disease Control and Prevention (CDC) has collected COVID-19 related data on a daily basis and regularly posts the data on its website. Case numbers are reproduced in chart form, as seen in the following figure from December 15, 2021. This is of course just an example of the opportunities for data collection and visualization. There are many other ways to represent the data that the CDC collects, and there are many other data sources that could be utilized. There are gaps, however, that academics could fill. In doing the research for this editorial, we were unable to find current graphics for data from the Midwest as a region, regardless of source. But beyond the reporting of daily statistics, there are no doubt many IS research questions that require access to COVID-19 data that would lend themselves to various sorts of data visualization.

Figure 1. Daily Trends in COVID-19 Cases in the United States Reported to CDC



Source: CDC Web Site

Another example of what is possible and relevant comes from some work done at Iowa State University. Early in the pandemic, Hridesh Rajan and his collaborators created the BoaC platform to facilitate analysis of an open research dataset on COVID-19 (http://boa.cs.iastate.edu/boac/). This dataset contains over 44,000 research papers collected over 64 years (Even, 2020). While this project originated in a computer science department, similar opportunities are available in the information systems area as well.

3. Zoom-like Platforms for Research and Teaching

As we all experienced in 2020, the use of Zoom and related platforms expanded greatly, as we used it for meetings (after meetings after meetings) and for teaching. In fact, the use of Zoom, in particular, expanded from 200 million meeting minutes in 2013, when it was first introduced, to over 3.3 trillion meeting minutes by March 2021 (Dean, 2021) during the pandemic. Since the beginning of the pandemic, behavioral researchers have studied how work and life have changed. Some of the best-known research was conducted in by communication scholars at Stanford University on the topic of 'zoom fatigue' (see, for example, Ramachandran, 2021, and Bailenson, 2021). There are many other topics related to the use of Zoom-like platforms, at work, at home, and for other activities, and IS faculty are well suited to explore these topics.

Many of us also employed videoconferencing platforms in our teaching, and some of us have already written about our experiences (cf. Barber 2021). As the pandemic continues, and as COVID-19 moves from pandemic to endemic, we will still be relying on these platforms, to some extent, in our teaching. Again, there are plenty of opportunities for IS faculty to write about their experiences and about the best practices they have discovered.

4. Social Media

Research on social media and its use during the pandemic has attracted much attention from researchers in IS and related fields. This is a very fertile field for research, and there are still many interesting research questions to be investigated. Here are two recent examples of published work in this area:

Zhong, Huang and Liu (2021) conducted an online study of 320 residents of Wuhan, China, in February 2020. They

found an increase in depression among respondents as the virus spread. Wuhan is considered the location of the initial incidence of the virus, so a study based there, inquiring about initial reactions to the pandemic, is especially worthwhile. The authors found that social media (in this case, WeChat), had a positive role. Respondents reported social media use helped mitigate stress and health risks through the exchange of "informational, emotional, and peer support."

Allington, Duffy, Wessely, Dhavan and Rubin (2021) conducted three online surveys in the UK (N = 949; 2250; 2254 – the last two were panels) about social media, health behaviors, and conspiracy theories. In all three studies, they found evidence of a negative relationship between conspiracy beliefs about COVID-19 (e.g., the virus was created in a lab; 5G mobile radiation causes the symptoms) and health protective behaviors, such as hand washing and staying inside. They also found a positive relationship between relying on social media as a key source of information and conspiracy beliefs.

5. What is Unique about the Pandemic in the Midwest?

While the research we publish in JMWAIS is not limited geographically, we have a special bond with the members of the MWAIS chapter and with faculty and IS/T professionals living and working in the Midwest. Our journal was created as a platform to communicate with each other about our research and to provide a way to highlight our work. All of the COVID related topics we've mentioned here (and there are certainly others) could be investigated anywhere. The research we cited was conducted in the UK, Germany, China, and elsewhere in the U.S., but note that some of the work was local. We referenced work done in both Iowa and Illinois and other part of the Midwest. And this calls attention to the question: What is unique about the pandemic in the Midwest? What can we say about it that reflects our region and its unique attributes?

Note that the Midwest has been the location of several COVID-19 hotspots since the pandemic began: South Dakota in September 2020; Indiana in November 2020; Michigan in April 2021; Missouri in July 2021. Why is that the case? And what research can we as IS scholars do to help understand the reasons behind this? There are other issues as well, related to our region's location and conditions. How can we extend and improve upon these research foci in our work in the Midwest? Here are some suggested research questions (but there are many others as well):

1) Why are we seeing COVID-19 hotspots in the Midwest? And what is the role of social media in the origins – and perpetuation – of these hotspots?

2) What can we learn about COVID-19 from large data sets dedicated to the number of cases, testing, hospitalizations, and deaths in the Midwest? Why is the Midwest more like the South than like the West or Northeast?

3) What are the best teaching practices we have developed in Midwestern colleges and universities for remote and hybrid classes? Are these practices influenced by anything unique to our region?

4) What are the best practices we have developed in the Midwest for remote work? Again, are these practices influenced by anything unique to our region?

5) What's unique about COVID-19 and how we are coping with it in the Midwest? And what role do information systems – at any level – play in this uniqueness?

Should you decide to pursue some of these questions, we wish you good luck in your research. And we look forward to receiving your manuscripts.

6. Overview of the Contents of this Issue

This issue of the journal includes two traditional research articles.

In their timely article, Kent Marett and Shan Xiao look at the relation between the availability of broadband Internet access and users' security knowledge. For their analysis, the authors have used both primary and secondary data. The findings of this study add another important reason to make broadband Internet access available as widely as possible.

Akmal Mirsadikov and Achita Muthitacharoen in their interesting article look at the possible connection between website user's motivation and their assessment of the site's credibility. The authors use eye tracking technology in this

study.

We appreciate and wish to acknowledge the contributions of reviewers for this issue of the journal, including Gaurav Bansal (University of Wisconsin, Green Bay), Queen Booker (Metropolitan State University), Sean Eom (Southeast Missouri State University), Yi "Maggie" Guo, (University of Michigan, Dearborn), Bryan Hosack (Penske Logistics), Barbara Klein (University of Michigan, Dearborn), Dahui Li (University of Minnesota, Duluth), Alanah Mitchell (Drake University), and Troy Strader (Drake University).

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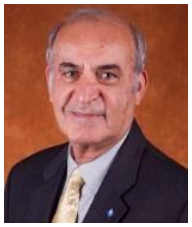

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Broadband Internet Access as a Localized Resource for Facilitating Information Security Knowledge

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Abstract

With an increasing number of threats to cybersecurity, research continues to focus on methods and behaviors by which individuals may better protect themselves. The availability of broadband infrastructure has been proposed to improve city and regional economic, educational, and health-related prospects, but its impact on facilitating security knowledge gathering has yet to be studied. This study assesses the influence of broadband availability, using data collected from 894 Internet users from across the United States, with multiple analysis techniques supported by geographical information systems (GIS). The results indicate that broadband access, in addition to age and education level, is associated with higher levels of security knowledge. Moreover, geographical weighted regression analyses suggest that the significant variables vary in influence based on their locality.

Keywords: Broadband Internet, information security, GIS, rural technology.

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1. Introduction

No matter the locale, broadband Internet access provides substantial benefits to people such as convenience, entertainment, and knowledge, with the hope that the public embraces new technologies and takes advantage of interconnectivity and data. However, Internet users can ill-afford to remain ignorant of security issues while enjoying the benefits the technology offers them. Insufficient information security is a significant vulnerability for both individuals and organizations given the increasing trend of information security breaches over many years, such as data corruption, identify theft, and credit card fraud. Organizations make investments on information security management like traditional technical methods and organization insiders' education to mitigate potential risks. Information security knowledge has been considered as one of the most effective behavior controls (Van Niekerk & Von Solms, 2010) as it positively influences an individual's intentions to protect one's information, resulting in the adoption of secure behaviors and countermeasures. By and large, maintaining current knowledge on topics and issues involving information security decreases the likelihood and damage caused by a security breach (Safa & Von Solms, 2016).

However, little research has been devoted to how the possible obstacle of inadequate broadband Internet access may contribute to a dearth of security knowledge among Internet users. Broadband diffusion does not occur on a regular, orderly basis; rather, it is largely dependent on evolving technology and the availability of public infrastructure funding. The consequences of inadequate access are often most visible in rural areas in which the population may lack the basic abilities to retrieve timely information to complete tasks, to draw from online healthcare or governmental services, or to communicate remotely with others, not to mention the lacking the entertainment and recreational benefits their counterparts in more populated areas enjoy (Slavova & Karanasios, 2018). From all accounts, limited broadband access in rural areas is a global phenomenon. The question is whether the limitations also lead to less secure population when understanding potential threats becomes an issue.

In order to better understand whether access to broadband Internet affects one's level of security knowledge, we draw from Triandis's (1984) original conceptualization of facilitating conditions. With *security knowledge* broadly defined as accurate information or skills pertaining to information security practices (Karjalainen & Siponen, 2011), we sought to investigate the following research questions:

> RQ1. To what degree does broadband Internet serve as a facilitating condition for individuals to stay current on information security knowledge?
>
> RQ2. Does the level of security knowledge among Internet users cluster around specific locations based on the influence of broadband infrastructure and other geographical factors?

To answer the first research question, we used exploratory regression and ordinary least squares (OLS) analyses of data produced by a nationwide survey to examine the influence of broadband Internet on individual security knowledge. The results identified several variables, including two related to broadband access, that helped explain variance in security knowledge. Because broadband access is highly contingent on one's location, we used a number of analytical techniques associated with geographic information systems (GIS) which have been used previously to study the accessibility of services in rural areas (Higgs & White, 1997; Sipple, Francis, & Fiduccia, 2019) to answer the second research question. The spatial assessment included both hotspot analysis and geographically weighted regression (GWR). Based on the previously identified variables, we detected regional clusters of high and low security knowledge and determined that the influence of broadband access appeared to fluctuate based on location.

2. Theory Review

To our knowledge, there is little to no research examining the capabilities provided by broadband access to gain and maintain current knowledge of information security, with one exception. In an exploratory study, Grobler, van Vuuren, and Zaaiman (2011) observed that citizens in rural South Africa who are deprived of broadband access tend to lack sufficient cybersecurity awareness, putting them in a vulnerable position that could be prevented with further investment into network infrastructure. To expand theoretically on that previous study, we draw from the underpinnings of Perceived

Behavioral Control by positioning broadband access as a facilitating condition for improving one's security knowledge, followed by theoretical rationale laid out by Social Learning Theory.

2.1 Perceived Behavioral Control and Facilitating Conditions

Ajzen's (2002) work on behavioral control stipulated that the absence of external resources could hinder performance no matter how high one's perceived efficacy and controllability may be. To that end, Triandis (1984) was among the first to put forth the notion of these external resources as "facilitating conditions" which, if present, would increase the likelihood of a behavior occurring, particularly when the party involved would need outside assistance in learning the behavior. This has often been operationalized in the IS literature as the degree of organizational support (i.e., company-based supervision and training) available to novices learning a new system (Thompson, Higgins, & Howell, 1991; Venkatesh, Brown, Maruping, & Bala, 2008), but Triandis posited that "the right equipment" also being available is crucial for success. In other words, the training and advice given in support of an attempt to improve one's skill set or increase one's knowledge is wasted if the tools and equipment needed for making the attempt are not present or are inadequate. Triandis' view of equipment and infrastructural support as being critical for facilitation parallels the development of perceived behavioral control by Taylor and Todd (1995a, 1995b). Their work partialed out the concept of "technology facilitating conditions" from other related constructs like self-efficacy and external support services. Taylor and Todd also made certain to note that, while the presence of facilitating conditions is no guarantee that intentions to use or to learn will be formed, the absence of facilitating conditions can impose barriers that prevent the formation of those intentions altogether.

In terms of maintaining a sufficient level of security knowledge to remain safe, the right equipment should include the support infrastructure that delivers current information to the individual. This is a sentiment that parallels work on technological factors necessary for facilitating statistics gathering by Anderson and Whitford (2017), who found that limited Internet availability in some global regions hinders governmental leaders' capacity to maintain timely information. Viewing broadband infrastructure as the "right equipment" for individuals to remain security aware necessarily follows in the spirit of Vourinen and Tetri's (2012) "security machine" and their description of subjection. By connecting one's home or business to the Internet, users are subjugated to security concepts and recommendations in order to keep the connection operational. As security is very much a dynamic exercise, with ever-changing threats, motives, and tools, maintaining an orderly information environment requires an equally dynamic pursuit of security concepts or recommendations. Failure to do so puts the user at a perpetual risk (Vuorinen & Tetri, 2012). As such, we expect that broadband access serves as the right equipment to facilitate staying current on topics and tools pertaining to one's information security.

2.2 Social Learning Theory

An additional theory is required to explain why people connected by broadband Internet would be expected to learn about information security. Social Learning Theory describes how individuals learn about their environment by vicariously observing how others behave within it and the consequences resulting from it, in addition to their own direct exposure to the same environmental conditions (Bandura, 1977). There are two facets of social learning theory that support our expectations that broadband users are likely to learn about information security. The first reason involves the learner's level of self-efficacy, or the level of one's belief to he or she is capable of performing a task. Where learning how to successfully manage a specific technology is concerned, repeated interaction with the technology along with a goal-oriented desire to master its management can motivate the learning process in order to increase one's self-efficacy (Marakas, Yi, & Johnson, 1998). Research on online education utilizes social learning theory to explain, among other facets of learning, how students naturally learn about the tools available to them and how they work by actively interacting with the facilitating technology (Johnson & Aragon, 2003). In a similar vein, we expect that broadband users will have an interest in staying current on how to safely and securely interact with the Internet access they have at their disposal.

The second reason we find social learning theory applicable to this study is the interaction with one's environment and the other people within as motivation for learning. This is the "viacarious capability" that Bandura (1985) models as a useful complement to experiential learning. Acquiring information from observing others' behavior allows for learning that is less constrained by limited time, resources, and mobility needed for personal trial-and-error. As we discuss later, broadband access occurs in geographical pockets with a dense population base. In these geographical areas, Internet providers have made investments in their network infrastructures with the expectation that a significant number of residents and businesses will be interested in subscribing to reliable broadband access. This results in a proximate peer

group of Internet users that, while not including everyone within a locale, will have a personal interest in better understanding the access they are subscribing to. In a proximate environment filled with like-minded users, learning about and staying current on a new technology is more readily embraced (Tsai, Shillair, & Cotten, 2017). Within the information security sphere, vicarious learning capabilities have been applied to employees learning about security through their membership in work groups composed of their peers (Abraham & Chengalur-Smith, 2019). We expect that in geographical locales that have broadband infrastructure available, people will have an osmosis-like opportunity to remain security knowledgable that does not exist in non-broadband-provisioned areas.

While organizations are commonly thought to provide much of the information security awareness, training, and knowledge needed by Internet users, efforts to do so are often irregularly offered and differ widely in quality (Hanus & Wu, 2016). Instead, individuals are often on their own for gaining security knowledge. According to previous research (Rader & Wash, 2015) and practitioner survey efforts (Olmstead & Smith, 2017), the main sources of personal security knowledge used by most individuals, for good or bad, frequently exist outside the workplace and include sources found online via social media and security websites. Online sources of security information also include streaming video services like YouTube (Eghan, Moslehi, Rilling, & Adams, 2020) which, by their very nature, require more bandwidth than static webpages. In a similar way in which broadband Internet aids in the conveyence of rich educational and telecommuting opportunities (Kinsell & DaCosta, 2014), broadband users are better equipped to explore and navigate multiple sources of security content than individuals utilizing lower bandwidth. Coupled with the geographic-based inequities of broadband access, we expect that individuals living in "digital deserts" lacking the facilitating infrastructure have relative difficulty maintaining their security knowledge.

2.3 Two Measures of Broadband Access

Though the ultimate focus of this study is determining whether a lack of broadband access could lead to unsatisfactory levels of security knowledge in a deprived locale, a dichotomous measure of broadband access or usage (either present or absent) is insufficient for a few reasons. First, the mere presence of broadband availability does not mean that residents are assured of accessing it. The cost of access may be too expensive to be practical, the individual may not own compatible technology, or the individual may simply be satisfied with existing non-broadband service (Horrigan & Duggan, 2015; Whitacre, Strover, & Gallardo, 2015). Second, we propose that one's interest in information security will be, at least partially, influenced by one's neighbors and fellow community members (D'Arcy & Lowry, 2019). In communities in which technology and information security are appreciated and possibly even prioritized, an individual's awareness may remain better attuned to security topics by virtue of his/her proximity to other aware individuals. Finally, the availability of broadband Internet would be better represented by a continuous measure rather than a binary measure in order to account for the competitive environment within a locale. A larger number of options also helps individuals overcome obstacles like affordability and compatibility (Gulati & Yates, 2012).

3. Method

This study involved the use of both primary and secondary data. The primary data was collected by surveying individual Internet users from across the United States. Government-led studies have concluded that broadband access in the United States is most likely to correlate with population clusters and urban densities (Copps, 2009; Stenberg et al., 2009). Indeed, the Federal Communications Commission (FCC) estimates that one-quarter living in areas defined as "rural" lacked a single fixed broadband provider. This percentage does not include people living in impoverished urban communities (Pick & Nishida, 2015).

Two methods of surveys were conducted in order to procure responses from people across a diverse geographical area in locales ranging in broadband availability. The first round consisted of online survey responses collected through a panel arranged by Qualtrics. Responses were elicited from Internet users living in the United States over the age of 18. A second round of responses was collected via paper surveys administered to Internet users residing in rural areas across seven US states. By administering the instrument in both online and paper versions, reaching a more diverse sample of respondents becomes more likely (Crossler, Bélanger, & Ormond, 2018), particularly when part of the sample is expected to have limited broadband access. T-tests indicated no significant differences in key variables based on the survey method used, and Levene's tests of inequality showed no significant demographic differences between the two methods. Incomplete surveys were rejected, as were those from respondents who failed an attention check item on the instrument. This method resulted in 894 usable responses.

Overall, the sample was 64 percent composed of female respondents. The mean age of the respondents was 45.5 years, with a mean of 16.5 years living in their current communities. Forty percent of the sample held either a bachelor's or graduate degree, with an additional 34 percent reported having attended some college. In terms of their primary Internet connection, 49 percent used cable modem, with 25 percent subscribing via DSL, 9 percent used their mobile devices, and 6 percent used FTTH (Fiber to the Home). The secondary data was obtained from publicly-available sources in the U.S. federal government, primarily the Federal Communications Commission (the FCC) and the US Census Bureau. The measures collected from both primary and secondary data sources are described in the following section.

3.1 Measures

Based on Triandis's discussion of objective facilitating factors, we represented the "equipment" with two measures of broadband infrastructure. As the zip code and ISP subscription information were reported by survey respondents, as well as the coordinate data associated with each response, we were able to ascertain both (a) the number of broadband options and (b) the potential downstream data rate for each response using the most recent Broadband Progress Report maintained by the FCC. The report tallies the number of Internet service providers for a given location by reporting ISP data rates meeting the FCC standard for broadband, 25 mbps downstream and 3 mbps upstream. 419 respondents lived in areas with one broadband option, with 277 having two options, 112 having no options available, and 86 with three or more (up to six) options.

Other variables pertaining to location and demographics were among the other possible candidate driving factors selected for the study. The FCC report also provided the reported data rate associated with the ISP each respondent subscribed to. For respondents who responded having access through more than one provider (including their Internet connection at work), the largest potential data rate among their providers was used, allowing for more conservative estimates. Some respondents indicated that their mobile device was their sole connection to the Internet, and in those cases we used the 4G potential data rate of 12 mbps (Fleishman, 2010), which was standard most widely available during the data collection period. Demographic variables, including the respondent's age, sex, race, and education level, are thought to associate with broadband usage (Sarkar, Pick, & Rosales, 2016) and were self-reported by the survey respondents. Location-based data, including the population of a resident's community, its population density, and the local median income were all collected from US Census Estimate Reports.

The dependent variable, security knowledge ("SECKNOW"), was assessed using a ten question quiz modeled similarly to knowledge assessments found in other security research (Giboney, Proudfoot, Goel, & Valacich, 2016). Each quiz question regarded a particular threat or countermeasure that relates to implementing one's own personal information security, with the questions drawn from existing security literature (Crossler et al., 2018). Quiz scores ranged from 0 to 10, and the overall mean for SECKNOW was 3.60 correct answers. An ANOVA indicated significant differences in SECKNOW ($F=28.04$; $p<.001$) based on the number of broadband options available, ranging from a mean of 6.20 for individuals with five or more options to a means of 4.84 for 2 options, 2.90 for one option, and 2.17 for no broadband option available. A similar statistical difference was found when grouping respondents by downstream data rates ($F=24.77$; $p<.001$). The 340 respondents who do not have a rate of 25 mbps had a mean of 2.65 for SECKNOW, which a Bonferroni comparison found to be significantly lower than respondents with 25-100 mbps ($M=4.00$), respondents between 100-500 mbps ($M=4.31$), and respondents with downstream rates over 500 mbps ($M=4.94$).

Comparisons of other measures collected in this study point to differences in the manner in which security knowledge is sought out. Overall, survey respondents reported using online sources ($M=4.69$) for seeking out security knowledge slightly more frequently than friends ($M=4.35$) and news media ($M=4.51$), and roughly equal to accessing sources at work ($M=4.71$). However, when comparing groups differentiated by the broadband measures, both individuals with access to three or more broadband options ($F=6.18$; $p<.001$) and individuals with high downstream data rates ($F=3.03$; $p=.029$) were more likely to use online sources for staying current on the latest security information than their broadband-deprived counterparts. Responses to open-ended questions about their information seeking often pointed out the convenience and ability to work alone in private when using online venues like security websites and social media.

The survey instrument was designed following suggestions made by Gregor and Klein (2014) to reduce the chances for common method bias. The dependent variable SECKNOW was collected independently from several of the independent variables, including the broadband access measures. No contextual cues about the nature of the study were provided to the participants prior to the survey's administration; they were merely told the survey asked about their feelings for broadband Internet. Further, the items on the survey instrument itself were randomized and participants were

assured of their anonymity.

3.2 Analysis and Results

For data analysis, we followed a similar sequential procedure used in previous spatial analysis research (Feng & Tong, 2017; Marett & Nabors, 2021). First, the potential influence of variables of interest on the dependent variable, SECKNOW, were assessed using exploratory regression. Once variables appearing to have a significant influence were identified, Ordinary Least Squares (OLS) was used to assess their relative strengths of association. Then, the spatial relationships of the variables were examined first using a hot spot analysis to determine spatial clustering of the regression residuals, followed by a geographically weighted regression (GWR) to assess the localized weights of the influential variables. All data analyses described below were performed using ArcMap 10.3.1, though the GWR procedure was replicated using GWR4, a software tool specializing in that analysis.

Table 1 below reports the inter-construct correlations between SECKNOW and the variables described in the preceding section. Specifically, the number of available broadband options ("BROADOPT") and downstream data rate ("DOWN"), demographic variables like the age, sex, race, and education level of the participant, and location-based variables like the population, density, and median income of the participant's resident municipality were considered. SECKNOW was significantly correlated with several of the potential explanatory variables.

	SK	BO	DOWN	Age	Sex	Race	Ed	Pop	Dens
SECKNOW									
BROADOPT	.36**								
DOWN	.17**	.23**							
Age	.07*	-.07*	.01						
Sex	-.11**	-.05	-.01	-.12**					
Race	.03	.10**	-.01	-.06	-.01				
Ed Level	.15**	.15**	.08*	.03	-.11**	.08*			
Population	.02	.15**	.12**	-.08*	-.01	.03	.10**		
Density	-.01	.32**	.05	-.10**	-.04	-.01	.08*	.41**	
Md Income	.06*	.40**	.08*	-.09**	-.06	.06	.18**	.12**	.35**

Table 1. Inter-construct Correlations (two-tailed). NOTE: ** p<.01, * p<.05

First, the exploratory regression included all of the variables described previously, regardless of correlation. None of the exploratory models violated the Jarque-Bera test for normality nor the Global Moran's I test for residual spatial autocorrelation. BROADOPT, DOWN, age, and education level were consistently significant and exclusively positive influences for all tested models, whereas the other variables were mixed influences if significant at all. None of the tested variables showed signs of multicollinearity. Thus, the four significant explanatory variables were included in the subsequent analysis using Ordinary Least Squares (OLS).

The results of the OLS analysis are summarized in Table 2 below. As hinted by the earlier exploratory regression phase, BROADOPT, DOWN, age, and educational level were all found to be significant influences. While age and higher educational levels seem to impact security knowledge to a certain extent, the model explained 15.6 percent of the variance in SECKNOW, with the BROADOPT variable explaining 12 percent on its own. *Post hoc* Global Moran's I tests were conducted to ensure no significant spatial autocorrelation bias was present in the dependent variable. The Variance Inflation Factor (VIF) statistics were also examined in order to assess redundancy among the variables, which is signaled by values over 7.5. None of the variables violated these assumptions.

To identify any possible spatial differences in security knowledge, two separate analysis techniques were undertaken. First, a clustering technique known as a hotspot analysis was conducted on the OLS residuals to determine whether spatial concentrations of security knowledge could be determined. Residuals represent the deviation from security knowledge expectations (based on the variables used in the OLS model) displayed by each respondent. Positive residuals between the observed and expected SECKNOW scores suggest an unexpected "overachievement" for an individual, and

	Unstandardized Coefficient	Standard Error	t-statistic	VIF	Variance Explained
BROADOPT	1.000	0.11	9.31***	1.08	0.12
DOWN	0.002	0.00	2.80***	1.06	0.02
Age	0.018	0.01	3.34***	1.01	0.01
Education	0.233	0.08	2.87***	1.03	0.01
F = 41.07*** Wald-Stat = 161.05*** R^2 = 0.156 Adjusted R^2 = 0.152			*** p < .001 ** p < .01 * p < .05		

Table 2. Results of OLS Analysis.

vice versa for negative residuals. The hotspot analysis calculated Getis-Ord G* statistics, which suggest whether the security knowledge exhibited by geographical neighbors was higher (a "hot spot") or lower (a "cold spot") than would be expected (the global mean based on the regression model) or resulting by random chance. Thus, a statistically significant result identifies a spatial area (here, a US county) that is not only above or below the expected average, it must also be located in a "neighborhood" of counties that show a similar high/low result. The results are graphically represented in Figure 1 below. Several regional clusters of significant hot- and cold spots were revealed, suggesting a localized influence for one or more of the variables.

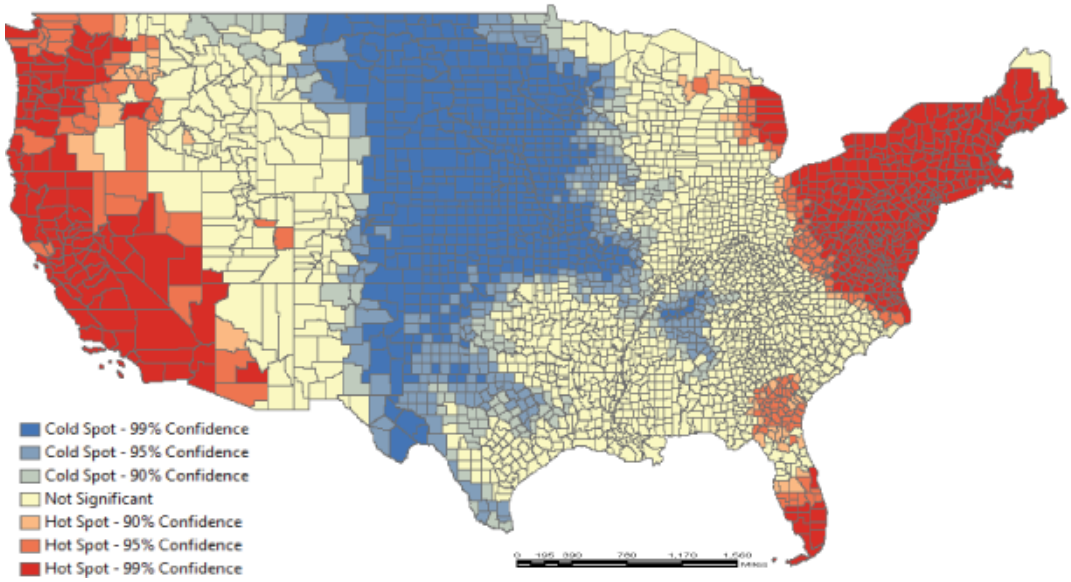

Figure 1. Hotspots and Coldspots of Security Knowledge at the County Level.

Thus, a GWR analysis was conducted to determine the level of spatial nonstationarity, i.e., the extent to which the global regression model might be calibrated for a particular locality (Fotheringham, Charlton, & Brunsdon, 1996). GWR supplements OLS by regressing the variables using a local model (i.e., the influence of a data point's neighbors is weighted higher than more distant observations) rather than a global model. By doing so, the resulting model identifies which variables are more influential, depending on their location. GWR has been demonstrated to be robust to all but the most extreme cases of multicollinearity (Fotheringham & Oshan, 2016), which appears not to have been an issue in this study.

A comparison of the OLS and GWR results suggests that the GWR model represents an improvement. The AICc value, which estimates the goodness of fit, was reduced from 4200.0 for the OLS model to 4176.7 for the GWR model, indicating a better model fit. The R^2 improved from 0.156 explained by the OLS model to 0.224 for the GWR model, suggesting a nonstational influence for one or more of the explanatory variables. The largest influence was provided by

BROADOPT with an R^2 of 0.184, with the additional variance explained by DOWN (0.02), education (0.01), and age (0.01). As a test for robustness, the GWR was also tested using an adaptive kernel, which further accounts for locales with different densities of observations (Du, Wu, Zhang, Liu, & Zhou, 2018), with the resulting R^2 lowering to just 0.213 and a slightly lower AICc (4176.0). Neither GWR model exhibited significant spatial autocorrelation. To provide a measure of robustness, the GWR analysis was replicated using GWR4 (Nakaya, 2016), and the results were consistent with those produced in ArcMap. A comparison of the overall GWR results with those from the OLS model is provided in Table 3.

	F	AICc	R^2	Adjusted R^2
OLS	41.07***	4200.0	0.156	0.152
GWR ArcMap (fixed kernel)	n/a	4176.7	0.224	0.185
GWR GWR4 (fixed Euclidean)	n/a	4178.8	0.220	0.181

Table 3. Comparison of OLS and GWR Models.

In sum, the results from the GWR suggest that the variables used in the OLS regression model can vary in their influence on SECKNOW based on the location of a particular observation. A subsequent test of geographical variability using GWR4 indicated that both BROADOPT (-15.81) and DOWN (-4.92) produced negative values when comparing the original regression model and the localized model, as opposed to the positive values for age and education, suggesting that the two broadband access factors contribute the most to localized variability differences.

4. Discussion

The results of the GIS analyses performed in this study can be summarized in the following ways. First, the exploratory regression analysis of both objective "equipment" measures and demographic variables identified variables like the number of available broadband options, the downstream data rate, and the age and educational levels of the respondent as being potentially significant influences on one's level of security knowledge. A follow-up OLS analysis confirmed these four variables as being influential, with BROADOPT contributing the most toward the model's explained variance. This result suggests that, as our first research question asked, broadband Internet can very much be viewed as a facilitating condition for improving one's security knowledge. As we expected, a hotspot analysis revealed geographic areas in the United States where respondents' security knowledge differed significantly from national averages and from what could be predicted by random chance. Finally, by constructing local regression equations via geographically weighted regression, we determined that the regression model demonstrates better fit when accounting for one's location. Variability tests comparing the original regression model and the geographically-weighted model suggest that the two broadband variables are responsible for the majority of any localized variability. Taken together, the results of the hotspot analysis and geographically-weighted regression support the notion that security knowledge can cluster around areas in which broadband Internet access is abundant and competitive, following up on the second research question. The results also support assertions made by social learning theory in which learning is more likely to occur vicariously due to a desire to know more about managing resources (here, the broadband connection and devices connected to it) that are a part of the local environment. The hot spots (and cold spots) identified by the geographical analysis suggest that learning and staying current on information security is very much localized to areas catered to by broadband providers.

In terms of implications for research, we believe the results of this study complements research on broadband investment that speaks to the assumed causality that infrastructure buildout will produce both immediate and long-term societal benefits without first influencing attitudes and behaviors by the newly-connected citizenry. As Pant and Odame (2017) point out, the benefits of improving broadband access will be maximized when technological improvements co-evolve with learning and innovation by customers. Our results highlight one area of this co-evolution. As broadband opportunities improve within an area, the population seems to engage in the learning that will help them take full advantage of the access while protecting them from evolving threats as well. Moreover, we suggest that there may well be a geographical factor to information security that has seldom (if ever) been accounted for. A recent examination of IS artifacts (Lowry, Dinev, & Willison, 2017) thought to be pivotal for security researchers to consider includes a number of social factors, such as cultural, organizational, and group-level influences on individuals. To that list of factors, we would add the need to account for geographical influences, including the availability of broadband connectivity. If there are truly isolated hot spots and cold spots of security knowledge that are, at least partially, related to the relative accessibility of broadband Internet, it would seem to be an oversight to expect that the location of individuals and the

organizations they work for will have the same priority on improving security knowledge.

This study also has implications for practitioners, starting with those who are involved with policy-making and investing in the broadband sector. As more communities and providers become involved in expanding broadband into underserved areas, whether through fiber initiatives (George & Petter, 2016) or an inclusive national 5G cellular network, the well-advertised economic, educational, and health benefits associated with broadband access are further bolstered by the results of this study. For business owners and managers, the results of this study take on additional meaning when considering that, despite their efforts to harden their own internal networks and systems, successful security often comes down to the practices of business partners and customers in a "lowest common denominator" environment (Lankton, McKnight, & Tripp, 2017). That is, managers have a vested interest in raising the levels of security education and awareness among members of the public that may have a current (or future) business relationship with. In addition to the other societal benefits discussed earlier in the paper, we believe that the business community should be among the strongest proponents for improving broadband access for their own security.

4.1 Limitations

The results reported here should not be assessed without acknowledging the limitations of this study. First, the data used in this study was collected entirely from Internet users in the United States. While limiting the data collection to one country made the geographical analysis presented here more practical, the cultural differences between nations make the results difficult to compare with cross-national studies on broadband penetration (Gulati & Yates, 2012). However, future research may find that the results here could apply to other geographically large countries or in nations in which the population is sparsely or unevenly distributed across wide areas.

Caution should also be taken when interpreting the results of a hotspot analysis conducted across a wide geographical area, as the physical distance between neighbors could weaken any cultural commonalities existing between data points. The results are the product of analyzing a sample of under 1000 Internet users. Although efforts were made to elicit a diverse geographical sample, we acknowledge there is no guarantee the sample was not fully representative. Also, the results should be assessed with the acknowledgement that sources of security knowledge are not mutually exclusive. While the availability of high-speed Internet might make the use of online sources of information convenient and more easily perused, knowledgeable individuals may have accumulated their information from a number of possible sources over time. As noted by Sandeep and Ravishankar (2018), employees frequently bring job-related information in through semi-permeable organizational boundaries from outside sources, and vice versa. Accordingly, it is increasingly difficult to know what security knowledge came from which source. This issue becomes more concerning as new technologies emerge and become available to consumers (Conger, Pratt, & Loch, 2013), especially rural users, who may not have equal access to security recommendations as others with better broadband.

One additional concern revolves around whether the results potentially suffer from endogeneity due to reverse causality. In other words, does an individual's security knowledge precede subscribing to broadband Internet because he or she feels safe from online threats? Or similarly, would broadband providers seek to develop in areas with existing, highly-knowledgeable Internet users? Van der Stede (2014) suggests reviewing the theoretical causal model to see if results are consistent with the explanation, determining if (at least) a correlational relationship between key variables exists, and then attempt to rule out plausible alternative explanations in order to make a confident, if not assured, argument against reverse causality. Here, our results indicate that the two broadband access variables do correlate significantly with security knowledge and that the OLS analysis supports the theoretical foundation for this study, that broadband Internet serves as a facilitating condition for acquiring security knowledge and that Internet users are better equipped to learn about securing their information due to the presence of their broadband access. The alternative argument for reverse causality suggesting that Internet providers seek out geographical pockets of highly knowledgeable users before building out broadband infrastructure does not seem plausible. Multiple reports and articles spanning the era in which broadband Internet has been commonly available in the United States (Beede & Neville, 2013; Copps, 2009; GAO, 2006; Grubesic & Murray, 2004; Lee, Brown, & Lee, 2011; Stenberg et al., 2009) claim the leading factors for buildout are population density, socioeconomic status, education level, regulatory right-of-way policies, existing or potential competition, and lack of obstruction due to the terrain. The security knowledge of the existing population base does not factor in to broadband infrastructure expansion, to the best of our knowledge.

5. Conclusion

This study represents a first attempt to examine an unexplored consequence of the digital divide in the United States –

a lack of information security knowledge found in areas underserved by broadband access. Ongoing efforts continue to improve broadband accessibility in rural areas of the United States, but the results of this study suggest that there is more to gain from doing so than the well-publicized educational, health, employment, and commercial benefits that individuals desire. Better exposure to information and tools necessary for protecting oneself while online also hangs in the balance, and we hope our results will encourage policy makers to continue deploying broadband access to underserved areas.

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The Role of Motivation in Assessing Website Credibility: Insights from Eye Tracking

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Abstract

A This study examines the role of a website user's motivation in forming her assessment of the website's credibility. We applied a dual processing model of website credibility assessment, which posits that motivation determines the extent to which users will critically evaluate website information and later form their credibility impressions of the website. In this paper we examine the relationship between motivation and cognitive processes and how those influence assessments of website credibility. We conducted an experiment using eye tracking technology to gauge the gaze behaviors of website users. We found that motivated users examined information content of the website more tentatively, while non-motivated users evaluated design features of the website more closely. Non-motivated users were inclined to assess the website as more credible. Findings from our study offer strong support for the dual processing model of website credibility.

Keywords: Dual-processing model, eye tracking, website credibility, experiment

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1. Introduction

In recent years, the growth of social media and the increased penetration of mobile and wearable technologies has made information ubiquitous and allowed businesses to constantly communicate with their targeted customers (Junglas and Watson, 2006). Subsequently, consumers are constantly exposed to "push" marketing by the platforms they use (e.g., Facebook, Instagram) to explore websites they mostly have not encountered before or were not even aware of their existence. Although the push marketing strategies can provide users with a more personalized experience, the user's encounters with unfamiliar websites/online sellers brought the issues of website credibility to a new level.

In the Human Computer Interaction (HCI) context, credibility is the perceived believability of information and is based largely on the trustworthiness of the source (Tseng and Fogg, 1999). Mandatory lockdowns brought on by global pandemics, such as the recent spread of COVID-19, raise the importance of e-commerce in supporting people's needs for everyday items. The impressions that the users form regarding a website are important as they determine whether a user would buy a service or goods. In the world of e-commerce, the credibility of the website is often the basis for consumers determining whether they will purchase from the site (Everard and Galletta, 2005). Researchers have looked into the attributes of the websites to determine users' assessment of the website (e.g., Cyr et al., 2006; George, Mirsadikov, et al., 2016; Wells et al., 2011).

Generally, people face a number of challenges when assessing the credibility of a website. On one hand, people evaluate different website elements (e.g., presence of contact information, easy navigation, design, updated content, etc.) when assessing the credibility of online information (Metzger, 2007). On the other hand, people have limited information-processing capabilities (Newell and Simon, 1972) and tend to focus on a smaller set of indicators, applying heuristics. While applying a heuristic information processing mode helps minimize a user's cognitive effort, there are circumstances when the information seeker should engage in a more deliberate and systematic evaluation of online information, as when they encounter an unfamiliar website or need to find accurate information. Motivation of the users, hence, impacts the way they evaluate information and form the credibility assessment. While prior research suggests that information seeker's characteristics (i.e., expert vs novice) influence the credibility assessment of information online, relatively little is known about the effect of motivation on credibility assessment (Lucassen et al., 2013; Metzger, 2007). Earlier studies found that motivation of website users led to increased concerns about the credibility of the source, however, these studies did not investigate whether more credibility concerns were associated with different credibility assessments of the websites (e.g., Hilligoss and Rieh, 2008; Rieh and Belkin, 1998).

Metzger (2007) proposed a model of Web site credibility assessment where a website user analyzes the semantic and surface information on the website applying a dual-processing approach. The model suggests that depending on their motivation, users look to different aspects of information on a website. Highly motivated users are likely to apply systematic, or relatively closer examination process, while less motivated users will resort to heuristic, or peripheral evaluation of the website features. Metzger's model suggests a clear role of motivation in determining which of the two information evaluation processes would be invoked. The more motivated the person is, the more likely it is they apply systematic/central evaluation.

To investigate the viability of the theory, we propose (i) to explore the relationship between user motivation, cognitive processes, and credibility assessment about websites and (ii) to examine what users actually look at to assess website credibility. Prior studies relied on self-reported responses of the participants in determining the credibility of website information. Whereas self-reports by participants constitute a valuable source of data, presence of more objective data should highlight website details affecting the credibility assessment. Prior research has demonstrated that the actual behavior of participants may differ from self-reports (e.g., Dimoka, 2011; Eysenbach and Köhler, 2002; Flanagin and Metzger, 2007). Thus, we propose an exploratory study addressing the following research questions:

1) What role does user motivation play in how they process information online?

2) How do mental processes affect how users assess a websites' credibility?

To investigate these research questions and to fill in the methodological gaps, we employ eye tracking technology.

While prior research has looked into the relationship between credibility assessments and a motivation to use certain media (e.g., Johnson and Kaye, 2010; Johnson and Kaye, 2015; Stavrositu and Sundar, 2008), the specific links between users' motivation and cognitive evaluation processes determining website credibility judgment have not been investigated. Thus, we have limited insight into the cognitive processes associated with a website credibility evaluation. We propose employing eye tracking technology to explore the impact of motivation on invoking the cognitive processes when assessing the credibility of an unfamiliar website. This methodology has been used extensively in human-computer interaction research and provides certain advantages over other traditional methods such as the ability to record users' objective and accurate real-time eye movements and to analyze users' gaze movements both quantitatively and qualitatively. Moreover, eye tracking provides an unobtrusive examination of how the mental processing of website elements takes place and affords insight into the content of information processing (Duchowski, 2007; Rayner, 1998). In this study, we propose examining gaze data as a quantitative technique for exploring the mental processes (i.e., central and peripheral) used to evaluate website credibility.

Despite the model's promise for researching website credibility, no research work, to the best of our knowledge, has attempted to empirically test it. The research community has called for studies to better understand how user motivation impacts credibility evaluations (e.g., Fogg et al., 2003; Metzger and Flanagin, 2013). Moreover, IS scholars have called for research measuring actual behavior of users instead of relying on the perceived measures of behavior and self-reports (Williams et al., 2017). The goal of this study is partly to respond to these calls.

Next, we briefly review the literature related to website credibility and eye tracking technology. We propose a research model and hypotheses. Then, we describe the research methodology and present our analysis. We conclude by discussing our findings and implications for research and practice.

2. Literature Review

2.1 Online Credibility

Credibility is generally defined as perceived believability of information (Tseng and Fogg, 1999). In the realm of e-commerce, credibility was consistently found to be an important factor affecting customers' purchase decisions (Everard and Galletta, 2005). While multiple studies examined the downstream effect of website credibility (e.g., Wells et al., 2011), some researchers looked into the antecedents to credibility (e.g., George, Giordano, et al., 2016; George, Mirsadikov, et al., 2016). A number of theoretical models have been proposed to help understand how information seekers form credibility assessments.

Metzer's (2007) Dual Processing Model of Credibility Assessment is based on the main idea of dual processing theories such as Elaboration Likelihood Model (Petty and Cacioppo, 1981) and Heuristic-Systematic Model (Chaiken, 1980), which suggest that information processing follows two routes (1) central and (2) peripheral, depending on the motivation and the ability of the user to scrutinize information (Figure 1).

Adopting the dual processing models to the web credibility assessment context, Metzger suggests that information seekers' motivation and ability determine to what degree users will evaluate the credibility of a website. More experienced or trained, as well as highly motivated, users are expected to scrutinize online information in more depth than novice or less motivated users. The model also posits two main routes of cognitive rigor when assessing online information: the central or systematic processing route involves deeper and more thorough cognitive effort to evaluate information, while the peripheral processing route is associated with minimal cognitive load and relies mostly on heuristics. Whether the systemic processing route or the heuristic route will be applied depends on the user's motivation and ability (Figure 1).

Fogg proposed prominence-interpretation theory (PIT) to explain how users of a web site come to assess its credibility. The theory suggests that two things happen when a website user evaluates it: the user notices some website elements (prominence) and later assigns meanings to those elements (interpretation) (Fogg, 2003). PIT suggests that a website user will not attend to all website elements, and any elements not noticed by the user will not contribute to the credibility assessment of the website. Fogg defines prominence as "the likelihood that a Web site element will be noticed." He suggests that a number of factors affect prominence, and the user motivation is the most important of those. Interpretation refers to persons' judgment about the element they notice.

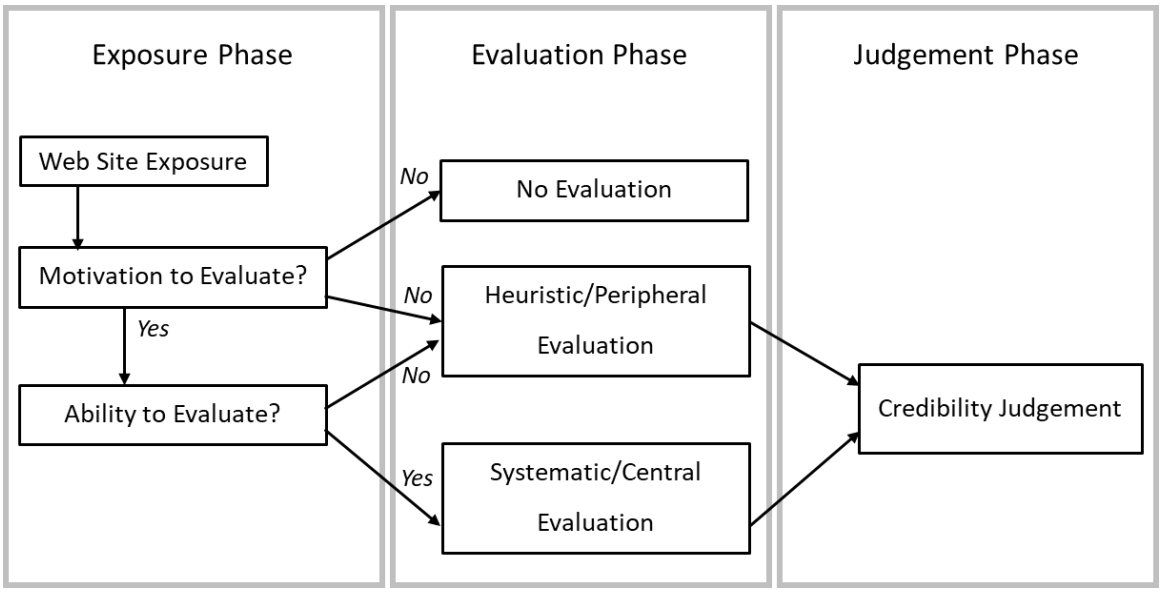

Figure 1. Elements of a Dual Processing Model of Credibility Assessment as Depicted in Metzger (2007)

2.2 Eye Tracking

It was postulated that self-reporting behaviors by participants may not be an accurate measure of actual behaviors (Eysenbach and Köhler, 2002; Williams et al., 2017). Remarkable advances in eye-tracking technology made it possible to more accurately detect what people see, compared to what they say they see. Eye-tracking has been used to study human behaviors for almost a century and has contributed to our understanding of activities such as reading, problem solving, search strategies, and overall processing of visual stimuli (Poole and Ball, 2006). The most commonly used metrics of eye-tracking studies are fixations, or spatially stable gazes, in which the subject's eyes are focused on a particular area, and saccades, or rapid eye movements that occur between fixations (Duchowski, 2007; Jacob and Karn, 2003). Gaze fixations are associated with visual attention and cognitive processes associated with a visual display (Bojko, 2013). A user who cognitively evaluates a particular website element exhibits higher gaze fixation frequency or longer gaze fixation duration associated with that element. As such, eye tracking metrics serve as a proxy to cognitive processes associated with the evaluation of the elements observed.

A clear advantage of eye tracking technology over traditional methods is that it offers accurate, timely, and unobtrusive means into what users actually focus on, without having to rely on self-reports. Schiessl and colleagues conducted four studies to compare objective eye-tracking data to conventional methods for assessing the allocation of visual attention of users (Schiessl et al., 2003). They found that self-reported questionnaires administered following the studies did not portray the participant behaviors accurately and could have led to improper conclusions if not compared with the results from eye-tracking data. They concluded that attentional processes do not solely depend on conscious control. Those processes are "often controlled beyond subjects' awareness, are therefore not reportable or are simply too fast to be analyzed by mouse movements" (p. 2). In another similar study, a group of researchers tracked the visual attention of individuals making simulated food-purchasing decisions to examine how self-reported viewing of nutrition facts labels related to objectively measured viewing obtained from eye-tracking technology (Graham and Jeffery, 2011). A post-task survey assessed self-reported nutrition information viewing, health behaviors, and demographics. Participants reported viewing nutrition label information at a higher rate than they actually did.

In information systems (IS) research, numerous studies have been conducted employing eye tracking. Prior work has examined the effect of social nudges on steering toward a desired action outcome (Kretzer and Maedche, 2018), how users assess banner ads online (Burke et al., 2005), how individuals process information and perform tasks of various complexity (Buettner et al., 2018), how human images affect website appeal and trust (Cyr et al., 2009), and in many other domains. In the light of the benefits and insight that NeuroIS tools offer, a group of prominent IS researchers urged scholars to employ tools such as eye tracking to measure complex cognitive processes (Dimoka et al., 2012). Given the noninvasive nature of the technology, along with decreasing costs of operation, the eye tracking method promises many interesting insights in IS

research.

2.3 Research Model

The Dual Processing Model of Credibility Assessment proposes that "… users look to different aspects of Web-based information to assess its credibility depending on their motivation…" (Metzger, 2007, p. 2088). This assertion is similar to Fogg's "prominence" in PIT (Fogg, 2003), which suggests that user motivation will determine what aspects of a website will get noticed by the user. Less motivated users are expected to assess a website's credibility by focusing on web design elements and graphics. Highly motivated users, on the other hand, are expected to assess beyond website surface features and dwell on semantic content, inspecting source information such as contact information, physical address, third party endorsements or recommendations. The variance in visual evaluation of the website elements can be captured by the eye tracking technology in terms of attention to specific website elements.

The model suggests that what and how users look at the website elements is a function of their motivation and the mental processes they utilize at any given time. Consequently, what they notice and evaluate on a website should affect their assessment of the website's credibility. A third-party's certificate of a site's security, for example, should elicit more confidence, whereas outdated information or broken links should raise concerns about the site's credibility. In a large-scale study of over 2500 participants, researchers found the link between what users noticed and how they formed their credibility assessments (Fogg et al., 2003). Forty six percent of responses suggested that design and look of a website influenced their credibility judgment. In a different study, participants mentioned physical store location and hours of operation as the most frequent element in assessing a website's credibility (George et al., 2016). This variance in focusing on visual elements of websites may potentially stem from variance in motivations and cognitive processes. The model does not propose a clear directionality from the cognitive processes to credibility judgment, and it makes no assertions whether systematic processing would lead to more or less favorable credibility assessments. We propose, however, that websites inspected under a lower scrutiny (i.e., peripheral processing) are expected, in general, to be evaluated as more credible. This line of reasoning comes from deception detection research, which suggests that people have a "truth" bias (Street and Masip, 2015). In daily interactions, people tend to believe what the other party communicates, unless they have reasons to be suspicious. Similarly, in the context of web credibility assessment, unless the confidence threshold of website users is breached, they tend to perceive the source as credible. Based on the propositions of the dual processing model, we propose our study hypotheses:

Hypothesis 1: Visual foci of website users will vary as a result of motivation, such that: Gaze fixations on website surface elements (e.g., design and graphics) will be higher for less motivated users, while gaze fixations on semantic elements (e.g., product details, company location, contact information, payment details) will be higher for motivated users.

Hypothesis 2: Central and heuristic cognitive processing routes should lead to variance in credibility assessment, such that users applying heuristic processing should assess a website as more credible.

In this study, we test the effect of user motivation, while controlling for other variables such as a user's ability or the underlying task. Experimental designs with fewer treatment factors allow for better investigation of the causal relationship (Dennis and Valacich, 2001). We hence propose a working research model, which examines the effect of motivation on cognitive evaluation processes and the subsequent effect of cognitive processes on the credibility judgment (Figure 2).

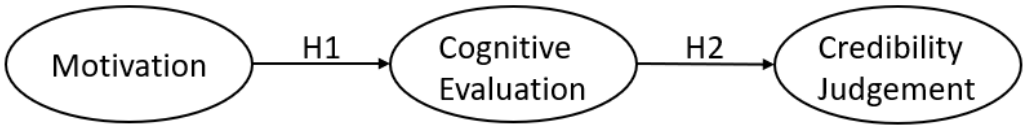

Figure 2. Working Research Model

3. Research Methods

3.1 The study

To test the causal relationship between the factors in the model and to test our hypotheses, we conducted a between-subjects experimental design. Before running the main study, we ran a pilot test with graduate students. The pilot study suggested whether the participants had sufficient understanding of the tasks, whether the treatment factor was effective, and the experimental procedure worked as designed.

We collected data at a Neuro lab at a large Midwestern university, using an eye-tracking system. We recruited thirty undergraduates in this study. Similar sample sizes are common for research work employing eye tracking technology because of the nature of collecting and interpreting eye tracker data (e.g., Cyr et al., 2009; Djamasbi et al., 2011; Yetgin et al., 2015). Half of the participants were randomly assigned to a treatment group and the other half to a control group. We used a scavenger hunt for a task, which was assigned to both groups. Participants were presented with the same commercial website of a small coffee and tea brewery business. This business offers a wide selection of gourmet coffee and tea, imported from various parts of the world. The business also offers catering services and barista classes at its multiple locations. A small-scale business with no name recognition was chosen to avoid brand recognition effect (Grewal et al., 1998). The scavenger hunt task involved locating multiple bits of information spread out across multiple webpages. Some tasks included searching for specific product details and is similar to the situation when a customer would search for a product online (e.g., finding price of a specific blend of tea, locating specific details about the product, etc.). Questions on the scavenger hunt varied in difficulty: some could be accessed with relative ease, whereas other questions required multiple clicks on website pages and thorough browsing. Participants in the treatment (motivation) group were promised a performance-based incentive (an additional $10 on top of their base participation compensation), while those in the control group were not. Monetary incentives to motivate participants in lab experiments are a common approach (Vrij, 2008).

To collect eye gazing behavior of the participants, we used an SMI RED 250 eye-tracking device, which is integrated to a 22'' monitor. Each participant was seated in front of the monitor and her/his gaze was calibrated and validated before the start of the experiment. Participants in the treatment group were reminded multiple times of the performance-based incentive. The participants first completed a practice task to make sure they were comfortable with using the equipment and understood the task. Next, they were allowed to start the main task.

The gaze behavior of the participants responding to the scavenger hunt tasks (i.e., browsing behavior) was captured and recorded by the eye tracker. They were not constrained on time, and on average it took around forty minutes to complete each study session. At the end of the experimental session, each participant was paid $20, whether they were in the motivation manipulation group or not, and regardless of how they performed on the experimental task. We asked the participants to assess the website's credibility on a 7-Likert scale. We also asked them whether anything on the website was confusing or unclear, and all of them indicated that nothing on the website was unclear. Next, they were debriefed and the experiment's purpose was explained. Last, we asked them not to discuss the details of the experiment with anyone until the study was over.

3.2 Measures

The cognitive processes are operationalized through the fixation metrics on target areas we defined. Central processing, based on the model, is associated with longer fixations on the information content of the website, while peripheral processing is associated with longer fixations on the design and graphics of the website. To measure cognitive processes, we used the gaze fixations of the participants, measured in milliseconds, on the specific website elements. Gaze dwell fixations on specific target areas are regularly used to gauge cognitive processes (Cook et al., 2012; Djamasbi, 2014; Rayner, 1998; Rayner et al., 2012). Longer fixation durations indicate higher level of attention and increased cognitive processing (Duchowski, 2007). We assigned areas of interests (AOIs) on website elements to quantitatively compare and contrast gaze fixations across different treatment groups. Delimiting specific AOIs enclosing perceptual elements is a common approach for data analysis (Djamasbi, 2014). To evaluate cognitive processes on the design and graphic elements of the website, we delimited website parts associated with its graphics. Specifically, we created separate AOIs for the website's logo, product pictures, and non-product associated photos (e.g., people at the barista course, nature scenery allegedly included to signal freshness of the products, etc.). We also created AOIs for the website parts associated with more detailed information. Specifically, we delimited text parts about general business information (e.g., company's mission, history, and "about us"

section), company contact information (i.e., address, phone numbers, and hours of operation), detailed product description including price, and payment information. In sum, we identified 7 discrete elements of the website (AOIs) which we planned to use in our analyses. Fixation duration was measured in milliseconds each time the gaze entered the AOIs. We transformed the data using square root transformation as the data was highly skewed.

We also measured the dependent variable, users' assessment of the website's perceived credibility, which they selected on a 7-point Likert scale, ranging from "very low credibility" to "very high credibility." The independent variable, user motivation, was coded as a discrete variable (0 and 1). We also measured the accuracy of the participants' responses to the given questions to determine whether our manipulation worked. We assigned different weighing scores based on the difficulty of the task. We also gauged how many web pages the participants observed when performing the task. We used the number of web pages as a control variable as it could affect fixation metrics: the more pages they open, the higher should be the fixation duration on AOIs. To control the effect of the number of pages opened from the experimental treatment, motivation, we treated it as a covariate.

4. Analysis and Results

A one-way ANCOVA was conducted to determine the main effect of the experimental manipulation. There was a significant effect of the treatment variable (motivation) on the performance measure ($F(1, 27) = 6.27$, $p=0.019$) controlling for the effect of the number of web pages they opened ($F(1, 27)=10.50$, $p=0.003$). Pairwise contrasts of the mean differences revealed that the motivated group outperformed the control group (mean difference= 4.51, 95% CI (.82, 8.21)). Hence, the experimental manipulation had its intended effect.

To test Hypothesis 1, a one-way ANCOVA was conducted to determine a statistically significant difference between motivated and non-motivated website users on cognitive processes, controlling for the number of opened web pages. Assumptions for independence of the covariate and treatment effect and homogeneity of regression slopes were met. Tables 1 and 2 show the estimates of marginal means and the tests of between-subjects effects, respectively.

Table 1. Estimated Marginal Means

Cognitive process	Fixation duration on DV	Motivation	Mean	Std. Error
Systematic/central evaluation	Product description	Non-motivated	114.7	7.6
		Motivated	145.3	7.6
	Payment details	Non-motivated	18.4	1.5
		Motivated	27.2	1.5
	Contact information	Non-motivated	69.9	4.0
		Motivated	85.6	4.0
	Business information	Non-motivated	260.9	12.4
		Motivated	301.3	12.4
Heuristic/peripheral evaluation	Company logo	Non-motivated	110.3	4.2
		Motivated	59.9	4.2
	Product pictures	Non-motivated	198.1	8.4
		Motivated	141.4	8.4
	Other pictures	Non-motivated	94.1	4.1
		Motivated	71.2	4.1

As predicted, motivated users tended to fixate longer on and examine information content, while non-motivated users seemed to process longer on the website's design and graphics. The tests of between-subjects effects were all statistically significant and in the predicted direction. We found support for Hypothesis 1.

Table 2. Tests of Between-Subjects Effects

Cognitive process	Fixation duration on DV	F	df	df (error)	sig	Eta sq.
Systematic/central evaluation	Product description	7.79	1	27	0.010	0.22
	Payment details	15.62	1	27	<.001	0.37
	Contact information	7.47	1	27	0.011	0.22
	Business information	5.17	1	27	0.031	0.16
Heuristic/peripheral evaluation	Company logo	68.83	1	27	<.001	0.72
	Product pictures	22.19	1	27	<.001	0.45
	Other pictures	15.44	1	27	<.001	0.36

To test Hypothesis 2, we ran a regression model. Because the total number of observations is relatively low compared to the number of predictor variables, we grouped predictor variables based on their type. Specifically, we combined AOIs for elements related to design elements - (i.e., those areas likely to be processed heuristically such as logo, product pictures and other non-product pictures) and combined AOIs for elements associated with information content of the website (i.e., areas likely to be processed systematically such as product description, payment details, contact, and business information). Regression results are shown in Table 3.

Table 3. Regression Analysis Results

Constant	.620 (2.046)
Systematic/Central Evaluation	-.007* (.004)
Heuristic/Peripheral Evaluation	.026*** (.006)
R-squared	.48
No. observations	30

Standard errors are reported in parentheses.
***p-value ≤ 0.01, ** p-value ≤ 0.05, * p-value ≤ 0.10

The results of the regression indicated the two predictors explained 48% of the variance (R^2=.48, $F(2,27)$=12.63, p<.001). The analysis suggests that systematic processing of website information did not significantly predict website credibility assessments (β=-.007, $t(30)$=-1.71, p=.099), however heuristic evaluation of the website elements did significantly predict users' credibility assessment (β=-.026, $t(30)$=-4.18, p<.001). We found partial support for H2.

5. Discussion

We began this paper with observations about how users may come across unfamiliar websites and the need to understand how they form their assessments of those websites. Mandatory lockdowns, such as those brought in by COVID-19 are likely to increase the reliance of users on e-commerce. We noted that research that investigates the role of motivation in assessing website credibility is scant and posed two research questions:

1) What role does user motivation play in how they process information online?
2) How do the mental processes affect how users assess the websites' credibility?

Using the Dual Processing Model of Website credibility assessment as the basis for our research, we conducted a study

using eye-tracking technology to address our research questions. We put forward two hypotheses and found support for both. We tested the effect of user motivation on evaluation processes, which were operationalized through gaze fixation duration on the website elements. We also tested the effect of underlying cognitive processes on the overall credibility assessment of the website.

Regarding RQ1, we found that participants evaluated website elements differently based on whether they were motivated or not. All participants noticed the elements we chose as areas of interest, but how they focused on those elements varied significantly (H1). Participants in the control group (i.e., non-motivated users) tended to fixate their gaze longer on the design and graphics elements of the website. Peripheral information processing was operationalized through the fixation duration on the design and graphic features of the website. As suggested by Table 2, motivation type explained the most variance (Eta sq. = .72) for assessing a company logo. Our study results suggest that non-motivated users were more inclined to evaluate the website using a peripheral cognitive process and focus on design features of the website, which is evidenced by longer fixations on the logo, product pictures, and other pictures. On the other hand, motivated users tended to go beyond the surface characteristics of the website and examine the site's information content. Our findings support the Dual Processing Model of Website credibility assessment's proposition that users look to different aspects of web elements, depending on their motivation for seeking information.

Regarding RQ2, we found that different modes of website information processing affected the credibility assessment of the website. As predicted, participants employing heuristic cognitive processes evaluated the website as more credible. Prior research suggests that website elements featuring graphics with human images, especially with facial features, induce users to perceive a website as more appealing and as more trustworthy (Cyr et al., 2009). Moreover, design elements, such as a logo, can communicate traits of credibility and trigger positive credibility assessments about the website (Lowry et al., 2014). As noted earlier, the most noticed feature of the evaluated websites was "design look," which was reported by 46% of around 2600 participants who were asked to judge website credibility (Fogg et al., 2003). A systematic evaluation of the website content, however, did not predict credibility assessments. When processing information more carefully, the same content may trigger different interpretations. For example, when asked to judge deception, the same cues noticed may lead to different assessments (Vrij, 2008). Some may interpret a quick response as an indicator of honesty, while others may perceive it as a rehearsed response, and hence a hint of deception. Similarly, website users assessing credibility will not necessarily interpret a commonly observed object in the same way. While one user may interpret a very professional-looking website as a sign of expertise and prestige and hence credibility, another user might see traits of corporate slickness and misrepresentation and hence as signs of very little credibility.

5.1 Implications

These results have important implications for research as they support Metzger's (2007) Dual Processing Model of Website credibility assessment. While dual processing models of information processing (i.e., Elaboration likelihood model and Heuristic-systematic model) have been extensively examined in the context of persuasion, no study, to the best of our knowledge, has attempted to empirically validate Metzger's model in the context of website credibility assessment. We employed eye tracking technology to capture gaze behavior of users accurately and objectively while they assessed the website and were able to unobtrusively tap into their cognitive processes as they examined different elements of the website. Findings from our study complement existing research with rich insights afforded by the reliable data, which are otherwise difficult if not impossible to obtain through self-reported data. Given our findings, we expect that investigating the entire model would help extend its utility and use. The model could be potentially corroborated by using fMRI technology to visually examine the images of the brain activated when evaluating a website.

Our research has practical implications, as well. Findings from our study suggest that users evaluate website elements differently depending on their motivation levels. Hence, graphics and design features, as well as quality content of the website, play an important purpose in impression formation, especially of new users. As such, web designers should be careful with introducing graphical elements that are unnatural or unexpected, as non-motivated users will be inclined to make a hasty impression of the website and leave it. Similarly, motivated users will evaluate information content of the website with greater scrutiny, and therefore information architects must ensure the accuracy and timeliness characteristics of information present on the website. Users exploring the website for the first time evaluate the website logo for signs of expertise and trustworthiness and extrapolate their impressions to the entire website's assessment. As such, a great deal of importance must be paid to design and placement of the company logo on the website.

5.2 Limitations

As would be expected, this study is not void of limitations. First, we recruited US college students for our study. While the experimental task is relevant to this group, people in other age demographics and other ethnic groups might display different web browsing patterns (Djamasbi et al., 2011), and as such, our findings should be treated with caution when generalized to the broader population. Second, we used a computer monitor to track users' web browsing behavior. Eye gaze data generated by other technology such as smartphones and tablets may display different gaze behavior metrics. Third, an inherent limitation of this study is the small sample size. Although similar sample sizes are common for studies employing eye tracking technology, a larger sample size is expected to offer a more stringent test of the relationships. Next, in running our experiment we asked participants to perform a specialized search task, and as such, generalization to groups performing different tasks (e.g., searching news, shopping online, leisure browsing, researching a critical health condition, etc.) should be treated with caution. Last, we did not investigate the impact of users' ability to test the dual processing model in its entirety. While the gap between experts and non-experts is shrinking in the web browsing domain, future research could investigate the impact of expertise on the cognitive processes and the overall website's credibility assessment.

6. Conclusions

Much has been studied about the importance of website usability. However, a website that scores high in usability (e.g., navigation, fast website, accessible from different devices, and others) can still have credibility issues. Credibility is an important construct in the context of e-commerce. Understanding the factors that influence its assessment has implications for both research and practice. Prior research has called for investigating the role of user motivation on forming credibility judgments about a website. Applying a dual processing model of website credibility and employing an eye tracking methodology, we examined the impact of motivation on the cognitive processes and were able to construct specific links between those processes and the credibility assessment of a website. This affords us a deeper and nuanced insight into the cognitive processes associated with website credibility evaluation. Our tests of the theoretical model help us understand its durability as a theory and its potential usefulness for the study of e-commerce, deceptive communication, and beyond. For practitioners, findings from our study will contribute to better understanding the visual elements that users attune to when assessing websites for small business owners. Investigation of credibility assessment of websites does not stop at just e-commerce but can be extended for any other activity that relies on websites – information gathering, communication, cloud computing, e-learning, and others.

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