8-9-2019

The influence of multimodal distractions on computer user performance

Ziyi Niu

The influence of multimodal distractions on computer user performance

By

Ziyi Niu

A Dissertation
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy
in Information Systems
in the Department of Management and Information Systems

Mississippi State, Mississippi

May 2019

The influence of multimodal distractions on computer user performance

By

Ziyi Niu

Approved:

Kent Marett
(Director of Dissertation)

Robert F. Otondo
(Committee Member)

Merrill Warkentin
(Committee Member/Graduate Coordinator)

Robert Adam Farmer
(Committee Member)

Gary F. Templeton
(Committee Member)

Sharon Oswald
Dean
College of Business

Name: Ziyi Niu

Date of Degree: May 2, 2019

Institution: Mississippi State University

Major Field: Information Systems

Director of Dissertation: Kent Marett

Title of Study: The influence of multimodal distractions on computer user performance

Pages in Study: 98

Candidate for Degree of Doctor of Philosophy

Information systems provide users with both valuable information that is relevant to users' tasks and irrelevant information that is not helpful to the user. Irrelevant information can potentially distract the users from their current task, thereby impairing performance. Guided by distraction-conflict theory, processing efficiency theory, attentional control theory, cognitive load theory and memory for goals theory, this study investigated the distraction effect by exploring the research question, "How do task-irrelevant distractions interrupt the users of information systems and influence their performance?"

To investigate how distractions from technology influence users' performance, this exploratory research examined the relationship between the variables of distraction, cognitive load, anxiety, and task performance. Data were gathered through a lab experiment using the iMotions eye tracking system. The findings suggest that task-irrelevant distraction negatively influenced the users by increasing anxiety and cognitive load as well as increase the time devoted to the primary task. The result also suggests that the cognitive load partially mediates the relationship between the distraction and the time spent on the task.

Keywords: Distraction, Eye tracking, Multitasking, User performance , Cognition, Cognitive Load, Anxiety

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation my professors. I sincerely appreciate your guidance and support throughout my Doctoral program. I am grateful for the wonderful people I met in the Mississippi State University. You have been incredibly helpful in guiding me through this process.

I would like to express my deepest grateful to Dr. Kent Marett, for your patience guidance and timely monitoring in my dissertation process. I am especially thankful to Dr. Merrill Warkentin, for all the expert knowledge and professional guidance. I express my sincere gratitude to Dr. Bob Otondo, for your constructive comments and valuable support. I am grateful to Dr. Robert Adam Farmer, for coaching me using the iMotions systems in my dissertation. I would like to thank Dr. Gary Templeton, for your encouraging words and insightful sharing. I also like to thank Ms. Nadine Rosinski and Angela Baker who were always helpful.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

With the development of modern technologies, a rapidly growing volume of information is exposed to users. Systems present information which may have potential value to the user or provide a benefit to other parties who target users as customers. However, systems provide users with valuable information that is relevant to users' tasks, as well as information that is not helpful to the current task. Unhelpful information can become a distraction and distract the user from his current task, there by impairing performance because distractions usually provide no direct value to the user and do not support the task at hand. Developers and users are concerned about the negative influence of distractions and are looking for solutions.

Information that is not applicable to the current task is not necessarily valueless since it may have value in other tasks. Information becomes a distraction only when users are exposed to it in a specific situation. Hence, distraction is an issue of human-technology interaction, which is a widely discussed topic in information systems research. Most information systems research in this stream focuses on technology's impact on user performance. Models such as information technology (IT) success (DeLone & McLean, 1992; Delone & McLean, 2003), unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003), and task-technology fit (Goodhue & Thompson, 1995), among others, have been used in this area to explain the link between information use and business value, which is the value creation process of information.

Research in this stream focuses on how information influences users' behavior through cognitive process.

Data becomes usable knowledge through users' cognitions. Researchers use theories to describe the process. For example, the signal detection theory describes how individuals select and refine useful signals from a large body of available information. Knowledge management theory explains how useable knowledge is transformed from information and how information is selected from data (Alavi & Leidner, 2001), while the media richness theory explores how information can effectively support task-solving when it fits the needs of the task (Dennis & Kinney, 1998). Previous research has explored the information use process and explained the factors which influence the effectiveness of information use.

When distraction happens, information acts as a distractor to users who have a specified task to complete. When working on a task, users may receive an enormous amount of information and expend considerable effort on detecting the relevance and trustworthiness of each piece of information. The distraction may increase the value of information input and increase the workload, which may influence users' performance on primary tasks. The distraction effect is widely studied in the information systems (IS) field. Research on distraction has two main streams. One steam is the study of distraction effect in multitasking, where users simultaneously perform multiple tasks or rapidly switch between tasks (Brooks, Longstreet, & Califf, 2017; Hadlington & Murphy, 2018; Magen, 2017; Moqbel & Kock, 2018; Ralph et al., 2014; Ralph, Thomson et al., 2015; Ralph et al., 2015; Schaap, Kleemans, & Van Cauwenberge, 2018; Srivastava, 2013; Szumowska et al., 2018). The other stream studies the distraction effect of interruptions, where an event leads users to fully but temporarily shift their attention from a primary task to other tasks and then return to the primary task (Addas & Pinsonneault, 2015, 2018; Adler & Benbunan-Fich, 2013; Altmann & Trafton, 2015; Alvarez et al., 2015; Drews & Musters, 2015; Hodgetts et al., 2015; Jenkins et al., 2016; Paul, Komlodi, & Lutters, 2015; Sanderson & Grundgeiger, 2015; Weng et al., 2017).

Multitasking and interruption studies have investigated the influence of distraction on users' performance. However, most distraction research focuses on task-relevant information, which can potentially support primary task-solving or performance on secondary tasks. Research on the impact of irrelevant information that is not associated with current task-solving remains limited. The negative impact of irrelevant information is an influential aspect of task performance that needs to be understood more broadly and has not been widely studied.

The goal of this dissertation is to investigate how task-irrelevant distractions from technology influence users' performance on primary tasks. This study utilizes eye-tracking technology, which has not been utilized in prior research of this area. It proposes a line of research that complements previous research on systems and information quality as it relates to human-technology interaction. Specifically, this study aims to examine the impact of emotions and cognitive loading aspects of the information distraction effect as it relates to information systems. It also incorporates cognitive loading and cognitive processes as antecedents of irrelevant information's impact on users.

1.1 Theories

1.1.1 Systems as Information Providers

Communication theory (Mason, 1978) treats an information system as a process used to produce information; system quality is a feature of the process, and information quality is a feature of the product (Delone & McLean, 2003; Petter & McLean, 2009). The concept of usefulness is explained by system and information quality, mediated by the use and user satisfaction (Seddon, 1997). Delone and McLean (2003) improved their original IS success model with service quality and integrated 'individual impacts' and 'organizational impact' as 'net benefit' The IS success model uses six criteria to measure the success of an information system: systems quality, information quality, service quality, systems use, user satisfaction, and net benefit. It has been widely used by researchers to examine the performance of an information system. This research stream explains the effect of technology on individual performance and supports the conceptualization of information systems as information providers (DeLone & McLean 1992, 2003; Goodhue & Thompson 1995).

As an information provider, technology supports users by replacing human effort with automatic technological processes which are more convenient and less expensive, as well as potentially more easily controlled and reliable, and by creating information based on raw data (Bravo, Santana, & Rodon, 2016; Zuboff, 1985). Such information is stored, organized, and analyzed for management activities in an organization (Bravo, 2016). As information providers, systems are designed to create value rather than focus solely on the user's current task; they inevitably generate some information that is irrelevant to the current task but may be valuable to the user in the future. The irrelevant information thus becomes a distraction to users as it diverts their focus from the current task.

1.1.2 **Drivers of distraction**

Users become distracted when their attention is diverted to extraneous stimuli. For example, when users collect data to complete a report, a notification may pop-up in a separate (but visible) window (Alvarez et al., 2015; Paul et al., 2015), some irrelevant reminder of an event may automatically display on the screen (Jenkins et al., 2016), a message from a friend may be received (Addas & Pinsonneault, 2015, 2018), or even a brief lag in the work process may distract users (Altmann & Trafton, 2015). Additionally, users may intentionally seek irrelevant information. For example, users often use social media while performing other tasks (Brooks et al., 2017; Gefen & Riedl, 2017; Hadlington & Murphy, 2018; Magen, 2017; Srivastava, 2013; Szumowska et al., 2018), talk to friends, or search for breaking news to reduce negative feelings (Adler & Benbunan-Fich, 2013). Users are also willing to use multiple devices simultaneously (Gupta, Burns, & Boyd, 2016; Nguyen, Barton, & Nguyen, 2015; Rambe & Bere, 2013; Scott et al., 2017; Tossell, Kortum, Shepard, Rahmati, & Zhong, 2015). Regardless of the source of the distraction, information technology enables users to temporally abandoned the primary at hand and shift their attention to irrelevant activities (Adler & Benbunan-Fich, 2013; Gupta et al., 2016). Distracting information diverts users' attention by providing external stimuli and interrupts users' performance on the current task.

Many types of mechanisms may be involved in the effects of distractive information. One is called the novelty-driven mechanism of selection (Gupta & Irwin, 2016). Distractive information captures users' attention by offering sensory modalities, such as visual and auditory (Andrés, Parmentier, & Escera, 2006). The distractive information provides the stimulus; users then activate an automatic novelty-detection response, and an involuntary re-orientation negativity response (RON) occurs (Gupta & Irwin., 2016). Another type of model explains the distraction effect in view of strategic settings described as 'goal-driven.' Users are considered more goal-consistent in this model (Norman & Shallice, 1986). The distractive information provides a stimulus, then the user evaluates whether the information is more important to accomplishing a goal than the current task; if the material is more helpful or useful, their attention may shift to the distractive information. Recently, empirical evidence has been found in a different context, resulting in the endogenous reward system and the related concept of being ‘reward-driven’ being incorporated into the literature (Anderson, 2013). The stimuli include some type of reward, and the person on task puts the reward into their consideration.

1.1.3 **Theories of distraction**

The distraction effect can cause the user to put the primary tasks aside and instead engage in irrelevant activities. In this case, the user deals with the tasks and the distractions consecutively. The users’ attention is shifted away from the task to the distractive information, which results in the primary task’s completion being delayed. However, in multitasking, the user engages in multiple tasks concurrently (Altmann & Trafton, 2015). Some researchers believe attention is a single resource (Kahneman, 1973); users alternate their attention between the primary task and the distraction because only one stimulus can be attended to at any given time (Jeong & Hwang, 2012). Other researchers disagree and suggest that attention involves multiple resources that can be simultaneously allocated to different tasks. This is explained in detail by multiple resource theory (Gupta & Irwin, 2016; Wickens, 1991) and threaded cognition theory (TCT) (Salvucci & Taatgen, 2008). In both consecutive and multitasking situations, the performance of the primary task is influenced by distractions.

Emotional distractions are processed by attentional demands (Siciliano et al., 2017), and a distraction’s influence varies depending on the context. Research suggests that low perceptual load, long presentation duration, and images with high emotional content create the largest distraction effect (Shafer et al., 2012), and emotional valence and attentional load are two factors used to explain the distraction effect on emotional attention (Siciliano et al., 2017). Research also suggests that the attention to stimuli is prioritized (Hartikainen, Siiskonen, & Ogawa, 2012; Schmidt, Belopolsky, & Theeuwes, 2015), and emotional distraction can influence the performance of tasks. Siciliano et al., (2017) used the ‘emotional oddball task’ to investigate the effect of emotional distraction. They found that increasing target discrimination difficulty caused the time required for detection responses to increase. They also found that target-related frontoparietal activity increases when exposed to emotional images, although the behavioral measures were not affected by this emotional distraction. When emotional images or content present a distraction, they initiate a series of neural activities requiring a response to the emotional stimulus. Increasing attentional load decreases the influence of emotional stimuli (Kurth et al., 2016; Lange et al., 2003; Pessoa, Kastner, & Ungerleider, 2002; Siciliano et al., 2017).

Humans have a limited information processing capability, so when the information input exceeds our processing limit, information overload occurs (Miller, 1956; Milord & Perry, 1977). Imposing time pressure on a task will ultimately lead to information overload (Speier, Valacich, & Vessey, 1999). As contextualized for IS research by Speier et al. (1999), an interruption is "an externally generated, randomly occurring, discrete event that breaks continuity of cognitive focus on a primary task" (Coraggio, 1990, p.19) and typically "requires immediate attention" and "insists on action" (Covey, 1989, pp. 150–152). When distractive information distracts a user, it delays or interrupts the primary task's completion; the overall cognitive processing load is increased, and the quality of the primary task may be influenced.

Two mechanisms of interruption may cause information overload (Speier et al., 1999). The first is time pressure, as when distractions take time away from completing the primary task. As time pressure increases, the user is more likely to suffer information overload. If the user deals with the stimulus consequentially, time pressure may occur because the user may need to refocus on the primary task. The second mechanism is the increasing demand on cognitive processing when the user multitasks to deal with the distractive information interruption. Cognitive processing may become more complex and result in information overload.

1.2 Research Object

IS research shows that information, which is created by diverse types of information systems, influence users' performance. This influence can be positive or negative and depends on the information's characteristics, which result from characteristics of the system which created the information. Research shows that the negative influence of an information system can be severe. IS research investigating media multitasking found that information distracts users by influencing their cognitive processes. Psychology research has studied the mechanisms of cognition and found different patterns, such as novelty-driven, goal-driven, and reward-driven. However, it remains unclear which pattern is more dominant in the distraction process (Gupta & Irwin, 2016). Furthermore, how irrelevant information influences user performance has not been sufficiently investigated. To fill this gap, this paper focuses on the following research question:

RQ: How do task-irrelevant distractions interrupt the users of information systems and influence their performance?

1.3 Conceptual research model / research method

Based on the existing literature on the distraction and IS research area, a conceptual model is developed to answer the research questions (see Figure1.1). This process model explains the mental process through which distraction influences user performance.

Figure 1.1 Conceptual model

This model claims that the distraction will increase anxiety and cognitive load, which will then negatively influence task efficiency by increasing the task-solving effort required, decreasing performance, or both. Three variables are designed to test the conceptual model. See Table 1.1 for a list of constructs with their definitions and sources.

Table 1.1 Definition of variables

Variable	Definition	Source
Anxiety	A state in which an individual is unable to instigate a clear pattern of behavior to remove or alter the event/ object/interpretation that is threatening an existing goal	Eysenck, Derakshan, Santos, & Calvo, 2007; Power & Dalgleish, 1997, pp. 206–207
Cognitive load	Cognitive load is a multidimensional construct representing the load that a specific task imposes on the performer	Paas & Van Merriënboer, 1994
Task Performance	The extent to which the individual has been able to effectively and/or efficiently carry out a task or tasks that involved use of the specific system	Serrano & Karahanna, 2016

1.3.1 Research Method

The dependent variable 'task performance' are measured by behavior data. To empirically test the behavior of respondent, a laboratory experiment is developed. Because this research aims at investigating the influence of specific factors on a dependent variable, an experimental design is used. The treatment in this design is used to induce an emotional response and influence the subject's cognitive processes to test the negative influence of distraction on user performance. To establish content and construct validity, the laboratory experiment was enhanced through expert panel reviews, two-wave pretests, and pilot studies prior to the main study. The instrument validity is increased by using reliability, and convergent and discriminant validity meet expected cutoffs.

The participants in this study were recruited from undergraduate students from various departments in the College of Business at Mississippi State University. The participants are an appropriate sampling frame because the students are information systems users and subject to experiencing emotional and cognitive reactions to distraction when using information systems. The findings of the study should be generalizable to a broader population.

1.4 The Significance of the Study

This study explained the cognitive process of distraction and predicted its influence on user performance. By differentiating multitasking and distraction behavior among information systems users, this study provides a holistic understanding of users' task performance. This research contributes to current theories by explaining the distraction effect on users' cognitive processes in the working situation. This research identified two paths of distraction influence: emotional and cognitive. These two paths can be used to explore users' behavior in other situations. Future study can further investigate additional factors that influence on those two paths.

This research contributes to real-world practice because it explains how emotional influence and cognitively influence of distractions influence the users' productivity on systems use. Organizations can set up rules or standards to control the influence of distraction. This research identified two factors which could potentially negatively influence users' performance: anxiety and cognitive load. Practitioners can mitigate the impact of distraction by boosting morale to reduce anxiety or improving the system to reduce the cognitive load.

1.4.1 **Organization of the Study**

This research is organized into five chapters with appendices. In this first chapter, I introduced the research background and explained the scope of this research. Additionally, I highlighted research questions and discussed potential contributions of this study. In Chapter II, I reviewed current literature related to user performance in the IS field, the psychology basis of distraction, the cognitive processes involved in distraction, anxiety and its influence on cognition, cognitive load and its influence on performance, multitasking research in the IS field, and the influence of multitasking on user performance. I also presented the conceptual research model and the hypotheses. In Chapter III, I explained the research methodology used in this study. I described the experiment design, experiment procedure, measurements and other considerations associated with the experiment. In Chapter IV, I tested the hypotheses and interpreted the findings. In Chapter V, I summarized the research by point out implication for research and concluded the findings.

CHAPTER II

LITERATURE REVIEW, MODEL, AND HYPOTHESES

2.1 Literature Review

2.1.1 Task Performance

Task performance is defined as "the extent to which the individual has been able to effectively and/or efficiently carry out a task or tasks that involved use of the specific system"(Serrano & Karahanna, 2016). It measures the extent to which an individual performs a task by meeting some minimal requirements (Carillo et al., 2017). This definition is similar to the definition of job performance, which is defined as "his or her overall job effectiveness" (Xiaojun, 2017, p. 815). Some other research definitions treat performance subjectively and view performance as a self-reported subjective feeling verbalized by the worker. For example, Moqbel, Nevo, and Kock (2013) defined task performance as the extent to which employees evaluate their own performance on the job. Because this study mainly focuses on how information distraction and multi-tasking behavior influence the output of a user, and the measurement of the construct is based on an objectively-measured scale, the subjective appraisal of performance is not used in this research.

In the IS field, many theories and models use task performance as the dependent variable, for example, the task-technology fit theory (TTF) (Goodhue & Thompson, 1995), IT success model (Delone & Mclean 1992, 2003), and Cognitive fit theory (CFT) (Vessey, 1991). These theories mainly focus on how technology influences individuals' task performance. The IS success model, CFT, and TTF all primarily emphasize the influence of information on task performance. TTF and the IS success model focus on the capability of the information system, while Cognitive fit theory focuses on how the information is presented. TTF and the IT success model aim to explain how the IT characters and human factors influence performance. TTF claims that an information technology must fit the task's requirements to positively impact user performance (Goodhue & Thompson, 1995). When the technology's characteristics fit the task's requirements, user performance will be enhanced (Goodhue & Thompson, 2006). The IT success model proposes that information quality, systems quality, and service quality can influence use and user satisfaction, and use and user satisfaction can influence user performance (Delone & Mclean 2003). CFT explains how task performance improves when the information's format corresponds to the task's requirements (Vessey, 1991). It suggests that when the information presentation format matches the task presentation, cognitive processes will be better supported, and higher quality decisions will be made (Vessey, 1991). A considerable amount of IS research is based on these three models and supports the positive influence of information systems task solving. Research in these streams has advocated the positive influence of information systems use.

On the other hand, some researchers have studied the negative influence of technology, such as negative influence of task interruption (Addas & Pinsonneault, 2015, 2018; Adler & Benbunan-Fich, 2013; Bera, 2016; Hodgetts et al., 2015; Paul et al., 2015; Sanderson & Grundgeiger, 2015) and multitasking (Brooks et al., 2017; Hadlington & Murphy, 2018; Magen, 2017; Moqbel & Kock, 2018; Nguyen et al., 2015; Rambe & Bere, 2013; Schaap et al., 2018; Scott et al., 2017; Szumowska et al., 2018) studies. These studies have found that the IT per se may possibly cause side effects and negatively influence individuals' work performance or daily lives. One stream of side effect investigation is the distraction effect of information systems use.

2.1.2 **Distraction Research**

Distraction is defined as "something that directs attention away from some ongoing activity" (Baron, 1986, p.4). Based on this definition, information distraction in the context of task performance refers to the irrelevant information that directs attention away from users' current task. The current task is the primary task, and all other tasks are secondary. When the secondary task is unrelated to the primary task, it becomes a distraction from primary task. For example, when users work with an information system, they may be exposed to other information. Processing data from information systems to complete their work is the primary task, and processing other information is the secondary task. If the information does not provide any value to completing the primary task, it becomes a distraction. Information distraction can originate from the specific systems which are used to complete the current task. For example, when a user uses email to send a message, another email may pop-up as a distraction. Distraction can also come from other systems; for example, when users are working, pop-up notifications from social media may distract them.

Distractions have varying levels of influence on depending on the individual. Some individuals are more prone to reactance than others (Drews & Musters, 2015)). These individuals are likely to limit their ability to use rational reasoning and perceive a challenge to their freedom. When they face irrelevant information, they may perceive it as a coercive task and attempt to ignore it. In this situation, the emotional reaction will lead their behavior instead of rational choice.

However, distractions can create positive results. Researchers have found positive effects of distraction, for example, when it is background music (Allan, 2006; Blood & Zatorre, 2001; Gefen & Riedl, 2017). When people are exposed to background music, but the music is unrelated to their primary task, the background music become a distraction. Furthermore, background music can affect decision making by increasing people's pleasure (Blood & Zatorre, 2001), as well as reducing customers' dissatisfaction caused by waiting (Peevers et al., 2009). Researchers have also found that background music can increase the amount of attention given to an advertising message (Allan, 2006; Gefen & Riedl, 2017). However, most of these positive effects are unrelated to the performance of a primary task. The negative influence of distraction on task performance has been found in many studies (Alzahabi & Becker, 2013; Baron, 1986; Brooks et al., 2017; Calvo, 1996; Eysenck, 1985; Eysenck & Byrne, 1992; Kalsbeek, 1964; Moqbel & Kock, 2018; Schaap et al., 2018), with only a few exceptions (Addas & Pinsonneault, 2018; Ralph et al., 2014, 2015).

2.1.3 **Distraction Effect on Performance in IS**

Distraction has received considerable attention in the IS field. The Association of Business Schools (ABS) publishes a list of recommended information management-related journals for the IS field (Kelly, Morris, Rowlinson, & Harvey, 2009). Using this list of journals, I conducted a search of the keyword 'distraction' and 'performance', as well as 'interrupt' and "performance," in "TX All Text" from the EBSCOHOST to collect articles related to the effects of distraction performance. Table 2.1 summarizes the main findings related to these topics in articles published between 2013 and 2018; it includes major articles in the list of ABS's list of recommended journals and several related articles which have been cited in published IS research.

Table 2.1 Main findings of recent research

Type of distraction	Definition in the specific research	Theory	Findings	Source
Self-interruption	Internally - motivated interruptions, which have been called self-interruptions to emphasize that the decision to pause occurs in the absence of external or environmental triggers.		Negative feelings trigger more self-interruptions than positive feelings. More self-interruptions result in lower accuracy in all tasks. Negative internal triggers of self-interruptions unleash a downward spiral that may degrade performance.	Adler & Benbunan-Fich, 2013
Distractive technologies	Distractive technologies are Web-based technologies that shift users' attention from relevant educational tasks and activities towards other social concerns.	N/A	The author investigated WhatsApp and find its positive and negative impact on academic behavior.	Rambe & Bere, 2013
Media multitasking	The act of seeking out multiple media and using them simultaneously.	Limited capacity theory for motivated mediated message processing	Media multitasking was associated with a decrease in message processing performance. Multitasking is associated with higher errors rates in recognition. Multitasking is associated with higher frequency of recall errors.	Srivastava, 2013

Table 2.1 (continued)

Media Multitasking	N/A	N/A	No correlation was observed between media multitasking and self-reported memory failures. Media multitasking was not related to self-reports of difficulties in attention switching or distractibility.	Ralph et al., 2014
IT interruptions	Perceived, IT-based external events with a range of content that captures cognitive attention and breaks the continuity of an individual's primary task activities.	N/A	Based on the content relevance of the interruption and content structure of interruption, interruption has diverse types. Some IT interruptions have positive effects on individual performance, whilst others have negative effects or both.	Addas & Pinsonneault, 2015
Brief lags as distractions	N/A	N/A	Brief, unfilled lags between trials improve place keeping accuracy on the post-lag trial. Rehearsal was the dominant strategy for maintaining place keeping information during interruptions.	Altmann & Trafton, 2015
Driver distraction	Driver distraction occurs when a driver is delayed from recognizing obstacles that could threaten their ability to maintain safe driving.	Multiple resource theory of attention.	Any kind of interaction to access information while driving has an impact on the driver's attention based on a decrease in driving performance and increase of cognitive load.	Alvarez et al., 2015

Table 2.1 (continued)

Interruption	N/A	N/A	Individual memory capacity differences affect performance during interrupted tasks by determining the selection of memory strategies and by limiting participants' performance.	Drews & Musters, 2015
Interruption	N/A	Memory for Goals theory	Both the temporal overview display (TOD) and change history table (CHT) types of decision support systems have negative effects on performance when recovering from an interruption.	Hodgetts et al., 2015
iPad as distraction	N/A	N/A	The author reviewed the research on iPad use in academic settings and found that the iPad has the potential to offer benefits to students. Students were found to be eager adopters of this technology. It is not clear how best to align and integrate it within the academic programs and workflow or how best to manage it as a resource within a university's organizational setting.	Nguyen et al., 2015

Table 2.1 (continued)

Interruptive notifications	Interruptive notifications are notifications that intend to draw the user's attention to inform the user of a new event or information.		Certain kinds of notifications support multitasking, task prioritization, and task management, as well as influence task disruption management.	Paul et al., 2015
Media Multitasking	N/A	N/A	There is no statistical relationship between habitual engagement in media multitasking in everyday life and a general deficit in sustained-attention processes.	Ralph et al., 2015
Interruptions and distractions	An interruption occurs when an event leads a person to remove his or her attention fully but temporarily from a primary, or current, task to another task, and then move their attention back to the primary task.	N/A	The author reviewed research in the area and summarized different forms of investigation are presently being used to address the issues of interruptions and distractions in clinicians' work.	Sanderson & Grundgeiger, 2015
Smartphone as a distraction	N/A	N/A	Participants reported that their iPhones were more of a distraction than a help to requisite learning for classroom performance.	Tossell et al., 2015
Color as distraction	N/A	N/A	Overuse or misuse of colors in business dashboards can distract users and have adverse effects on decision making.	Bera, 2016

Table 2.1 (continued)

Distracting effects of texting while driving		Theory of reasoned action, general theory of crime	Individuals who are more actively involved in texting while driving possess a lower risk propensity, are less likely to perceive risk in texting while driving and more likely to be involved in other potentially risky behavior than individuals who are less actively involved in texting while driving.	Gupta et al., 2016
interruptive alerts as distractions	N/A	Dual-Task Interference (DTI) Theory	Performance on the interruptive message itself decreases when it interrupts a primary task. The effects of DTI can be alleviated by timing alerts to display between primary tasks rather than interrupting a primary task.	Jenkins et al., 2016
Media multitasking	N/A	Distraction-conflict Theory	Perceived distraction from social media is positively associated with social media-induced technostress.	Brooks, Longstreet, & Califf, 2017
Musical distraction	N/A	Framing theory, social identification theory, trust theory	Music can be distracting. Distraction can be positive.	Gefen & Riedl, 2017
Media Multitasking	N/A	N/A	Frequent media multitasking is associated with deficits in many aspects of everyday goal-directed behavior.	Magen, 2017

Table 2.1 (continued)

Mobile devices as a distraction	N/A	N/A	Medical students, physicians and patient's concerns about the distraction effect of using mobile devices for learning in clinical settings.	Scott et al., 2017
Interruptions	N/A	N/A	Visual cues increase the probability that participants would defer interruptions.	Weng et al., 2017
E-mail interruptions	E-mail interruptions are externally triggered temporary suspensions of an individual's primary task activities to process the content of one or more incoming e-mail messages.	action regulation theory (ART)	There is a negative indirect effect of exposure to incongruent interruptions through subjective workload. There is a positive indirect effect of exposure to congruent interruptions through mindfulness.	Addas & Pinsonneault, 2018
Media Multitasking	Media multitasking (MMT) is defined as the simultaneous use of two or more types of media or a persistent alternation between media types.	N/A	Heavy media multitaskers (HMM) demonstrate more frequent risky behaviors than light media multitaskers (LMM) or average media multitaskers (AMM). The HMM reported more cognitive failures in everyday life than the LMM. Media multitasking acted as significant predictors for risky cybersecurity behaviors.	Hadlington & Murphy, 2018

Table 2.1 (continued)

Task distraction from Social networking site	Distraction refers to competing reaction tendencies.	social cognitive theory	Social networking site addiction fosters task distraction. Task distraction reduces performance.	Moqbel & Kock, 2018
Media multitasking	In multitasking, users perform two cognitive tasks simultaneously or switch between tasks rapidly.	Cognitive load theory	Second screening negatively impacts factual recognition and program liking.	Schaap et al., 2018
Media multitasking	Media multitasking is defined as engagement in several simultaneous activities; at least one of which must be media related.	N/A	High media multitasking levels were associated with more task switches between tabs for participants with low self-regulation ability. Media multitasking frequency and performance on multiple tasks were negatively related only in the free switching condition and not in the sequential condition.	Szumowska et al., 2018
Security warning	N/A	N/A	Participants' attention to warnings decline over time and attention recovers at least partially between workdays without exposure to the warnings. A polymorphic design substantially reduced habituation of attention.	Vance, Jenkins, Anderson, Bjornn, & Kirwan, 2018

IS research has investigated the distraction effect on performance from unique perspectives and generated a variety of findings. Researchers have found that distractions have a negative influence on users' performance (Addas & Pinsonneault, 2015, 2018; Alvarez et al., 2015; Bera, 2016; Jenkins et al., 2016; Magen, 2017; Moqbel & Kock, 2018; Rambe & Bere, 2013; Schaap et al., 2018; Srivastava, 2013; Szumowska et al., 2018; Tossell et al., 2015). Some research has only focused on primary tasks to determine how distractions influence users' cognition and how the distraction decreases performance on the primary task, as well as the performance of might be primary tasks (Adler & Benbunan-Fich, 2013; Altmann & Trafton, 2015; Alvarez et al., 2015; Bera, 2016; Drews & Musters, 2015; Moqbel & Kock, 2018; Rambe & Bere, 2013; Schaap et al., 2018; Scott et al., 2017; Srivastava, 2013; Tossell et al., 2015). Some researchers have focused more on secondary tasks, while some others have investigated the influence of distraction on both primary and secondary tasks (Adler & Benbunan-Fich, 2013; Jenkins et al., 2016). For example, Paul, Komlodi, and Lutters (2015) found that notifications can support multitasking and influence task-disruption management. Vance et al. (2018) found that a security warning, which is a distraction from the primary task, can be more effective when a polymorphic design is used. In addition to user performance, other negative influences of distraction were also found in previous research. For example, media multitasking increases risky behavior (Hadlington & Murphy, 2018), distractions are often associated with cognitive failures (Hadlington & Murphy, 2018; Magen, 2017), and the distraction effect of texting while driving makes drivers perceive lower risk levels and engage in more potentially risky behavior (Gupta et al., 2016).

Several studies have identified some positive effects of distraction, such as reducing technostress (Brooks et al., 2017) and creating positive feelings (Gefen & Riedl, 2017), and media multitasking has been shown to support academic work (Nguyen et al., 2015). In some other research, the influence of distraction is not significant or is dependent on other factors; for example, Ralph et al. (2015) found that habitual engagement in media multitasking does not create a deficit in sustained-attention processes. In another study (Ralph et al., 2014), they observed no correlation between media multitasking and memory failures/difficulties in attention switching/distractibility. Szumowska et al. (2018) found that multitasking negatively influences the performance of primary tasks in a 'free task-switching' situation but not in the sequential task condition. Addas and Pinsonneault (2018) found that email interruptions positively influence performance on primary tasks when they are related to the primary task but negatively influence performance when they are irrelevant to the primary task.

These recent research articles show that there are two distinct types or source of distractions: interruption and multitasking. In the interruption type of distraction, the distractor is an unexpected or unplanned event which happens during the primary task, such as receiving an email (Addas & Pinsonneault, 2018), a systems alert notification (Jenkins et al., 2016), a security warning (Vance et al., 2018), or other notification (Paul et al., 2015), as well as the when the system is lagging (Altmann & Trafton, 2015) or temporally unusable (Hodgetts et al., 2015). In the multitasking type of distraction, the distractors are usually planned, and the users know there will be a distraction. Some examples include media multitasking (Brooks et al., 2017; Gefen & Riedl, 2017; Hadlington & Murphy, 2018; Magen, 2017; Ralph et al., 2014, 2015; Schaap et al., 2018; Srivastava, 2013; Szumowska et al., 2018), using a smartphone during classroom instruction (Tossell et al., 2015), using an iPad for academic purposes (Nguyen et al., 2015), and texting while driving (Alvarez et al., 2015).

A variety of theories have been applied to investigations in this research stream, such as distraction conflict theory (Brooks et al., 2017), cognitive load theory (Schaap et al., 2018), limited capacity theory for motivated mediated message processing (Srivastava, 2013), multiple resource theory of attention (Alvarez et al., 2015), and memory for goal theory (Hodgetts et al., 2015). Most of these theories are associated with humans' working memory.

2.1.4 Working Memory

Working memory is defined as the process by which information is maintained in an activated, online state to guide behavior (Baddeley, Logie, Bressi, Sala, & Spinnler, 1986). Baddeley et al. (1986) proposed a working memory model that explains the working memory system as consisting of three parts: a central executive in the information processing and self-regulation function, a phonological loop for storing and interpreting verbal information, and a visuospatial sketchpad for processing and storing visual and spatial information.

There are three functions in the central executive component of working memory, including inhibition, shifting, and updating (Eysenck et al., 2007; Miyake et al., 2000). Eysenck et al. (2007) provided a definition of these three functions. The inhibition function is "one's ability to deliberately inhibit dominant, automatic, or prepotent responses when necessary" (Miyake et al., 2000, p. 57), while the shifting function is for "shifting back and forth between multiple tasks, operations, or mental sets" (Miyake et al., 2000, p. 55), and the updating function is for "updating and monitoring of working memory representations" (Miyake et al., 2000, p. 56)

All three of these functions are influenced when a distraction occurs. The inhibition function uses attentional control to resist distraction from task-irrelevant stimuli or responses (Eysenck et al., 2007). When responds to the distracting stimuli, the inhibition function can be influenced, especially when tasks are very demanding (Graydon & Eysenck,1989). When the distraction successfully draws a user's attention away from the primary task, the shifting function is responsible for shifting attention back to the current task. This function involves adaptive changes in attentional control based on task demands (Eysenck et al., 2007). The updating function's role is updating the representation in the working memory. When distractions occur, the distractive stimuli will create a representation in the working memory. Because the capacity of working memory is limited, the available resources will be used on the updating function, and attention to the primary task will be reduced. Overall, the adverse effect of distracting stimuli increases with the task's requirement on working memory (Graydon & Eysenck, 1989; Lavie, Hirst, de Fockert, & Viding, 2004). The increased requirement of tasks could cause information overload.

Information overload is "a state of affairs where an individual's efficiency in using information in his or her work is hampered by the amount of relevant, and potentially useful, information available to him or her" (Zha et al., 2018, p.227). An individual's cognitive ability is restrained by his or her working memory capacity (De Jong, 2010), which is limited (Miller, 1956). If the user's cognitive ability cannot fulfill the requirement of the user's task, the user's performance will decrease. Irrelevant information influences cognitive resource allocation and decreases the attentional resources available to complete the primary task. Also, since the stimulation of the irrelevant information requires attentional resources, the available attention for performing the task will temporarily decrease. Based on the idea that humans have a limited information processing capacity, many theories have been developed to explain the influence of distraction, such as distraction conflict theory (Brooks et al., 2017), processing efficiency theory (Eysenck, 1985), attentional control theory (Eysenck et al., 2007), cognitive load theory (Schaap et al., 2018), limited capacity theory (Srivastava, 2013), and dual-task interference theory (Jenkins et al., 2016).

2.1.5 Distraction-Conflict Theory

Distraction-conflict theory suggests that secondary tasks can distract individuals' cognitive processes and influence information processing, which is required to complete the primary task (Baron, 1986). All irrelevant stimuli can be distractions from the task at hand. Distractions create attentional conflict between the primary task and the distractor, especially when the distractor is difficult to ignore (Baron, 1986; Eysenck et al., 2007). The cognitive conflict creates information overload, which increases the individual's stress level.

When distractions occur, the individual must decide how to respond. The decision-making process increases the stress level in addition to increased time pressure, which is caused by devoting time to responding to the distraction (Baron, 1986). Research on distractions has found that stress is an environmental stimulus and can be distractor to someone who is working on a task; this effect is called distraction stress (Kalsbeek,1964). When an individual already has a primary task and then encounters a secondary task, they get distracted (Kalsbeek,1964).

2.1.6 Processing Efficiency Theory

Processing efficiency theory proposes that anxiety causes worry and worrying would impair the processing efficiency of the central executive on tasks (Eysenck & Calvo, 1992). When the task requires high attentional resources, the adverse effect of worrying will be severe (Eysenck & Calvo, 1992). There are two assumptions in processing efficiency theory. First, the effects of anxiety on performance effectiveness and efficiency are associated with worry.

Worrying affects the task-solving process by temporally occupying the cognitive process and consuming working memory (Eysenck et al., 2007).

The processing efficiency theory differentiates effectiveness and efficiency. Effectiveness is defined as "the quality of task performance indexed by standard behavioral measures (generally, response accuracy)" (Eysenck et al., 2007). In contrast, efficiency is defined as "the relationship between the effectiveness of performance and the effort or resources spent in task performance" (Eysenck et al., 2007); it refers to the quality of performance created by the unit of effort. Efficiency decreases when more effort and resources are invested to achieve a given performance level, or when a given amount of effort and resources are used and create a lower performance level.

Hence, the measurement of effectiveness is different from efficiency. Performance effectiveness is measured by the quality of the performance, while process efficiency is measured by performance effectiveness divided by effort (Eysenck & Calvo,1992). In the context of distraction, the negative effects of anxiety are significantly greater on efficiency than on effectiveness (Eysenck et al., 2007).

2.1.7 Attentional Control Theory

Attentional control theory is based on processing efficiency theory (Eysenck & Calvo, 1992) and explains how anxiety impacts working memory by impairing central executive functions (Eysenck & Derakshan, 2011). It claims that the impairment in central executive efficiency is caused by decreased attentional control. Specifically, these adverse effects are due to the impaired ability to inhibit and shift attentional resources, which happens in the central executive function (Eysenck et al., 2007).

Attentional control theory claims that the efficient functioning of goal-directed attentional systems can be influenced by anxiety, which is caused by a stimulus-driven attentional system (Eysenck et al., 2007). This theory explains the effects of trait anxiety on the attentional control system, as well as overall working memory (Eysenck & Derakshan, 2011).

2.1.8 **Anxiety**

Anxiety can be viewed as an emotional state or a personality trait (Speilberger, 2010). State anxiety is defined as "a state in which an individual is unable to instigate a clear pattern of behavior to remove or alter the event/ object/interpretation that is threatening an existing goal" (Power & Dalgleish, 1997, pp. 206–207). It describes an emotional state, including feelings of apprehension, tension, nervousness, and worry accompanied by physiological arousal (Speier et al., 1999). When it describes a personality trait, it can be defined as "a motive or acquired behavioral disposition that predisposes an individual to perceive a wide range of objectively non-dangerous circumstances as threatening and to respond to these with state anxiety reactions disproportionate in intensity to the magnitude of the objective danger" (Speier et al., 1999, p. 17). Individuals who have high levels of the anxiety trait are more prone to experiencing intense feelings of apprehension, tension, nervousness, and worry accompanied by physiological arousal.

Anxious individuals are distracted more by task-irrelevant stimuli such as worrying or irrelevant information. Anxious individuals prefer responding to threat-related stimuli over neutral stimuli (Eysenck et al., 2007). Highly anxious individuals may perform at the same level as individuals with low anxiety, but highly anxious individuals expend more effort (Eysenck et al., 2007). Empirical research has found that anxious individuals are influenced more by distracting stimuli than non-anxious individuals did (Calvo, 1996; Eysenck & Byrne, 1992; Graydon & Eysenck, 1989). Also, the adverse effects of distracting stimuli on the performance of anxious individuals are often greater than on non- anxious individuals when the distracting stimuli are threat-related rather than neutral (Eysenck & Byrne, 1992; Eysenck et al., 2007).

Gaining a better understanding of the effect of anxiety on cognition processes is fundamental to understanding how task performance is influenced by anxiety. State anxiety occurs in threatening circumstances, and the level of anxiety is influenced by trait anxiety and situational stress (Eysenck et al., 2007). It increases attention to stimuli and affects processing efficiency through two functions of attentional control: inhibition and shifting (Eysenck et al., 2007).

Anxiety negatively influences performance on difficult tasks (Eysenck & Calvo, 1992): anxiety causes worry, and worry impacts processing efficiency during tasks which have high attention and working memory demands (Eysenck & Calvo, 1992). Furthermore, anxiety influences efficiency more than effectiveness (Eysenck & Calvo, 1992). In some situations, anxiety may not influence performance quality because the anxiety also motivates individuals to use compensatory strategies such as increased effort or processing resources, and these strategies may increase performance effectiveness (Eysenck et al., 2007).

Attentional control theory assumes there are two attentional systems; one relates to top-down, goal-driven processing and other to bottom-up, stimulus-driven processing (Eysenck et al., 2007). Both attentional systems are active when individuals work on a task. Anxiety disrupts the balance between these two systems by increasing the influence of stimulus-driven systems and decrease the influence of goal-directed ones (Eysenck et al., 2007). Anxious individuals prefer to allocate intentional resource to stimulus-driven processing systems and reduce resource allocation to goal-driven systems, which influence the performance of primary tasks.

Attentional control theory assumes that anxiety influences performance through worry (Eysenck et al., 2007). Worry is defined as predominantly verbal thinking focused on uncertain future events with a potential negative outcome (Eisma et al., 2017). Worry is related to task performance. According to attentional control theory, worry impairs efficiency more than effectiveness. Worry's influence on attentional control does not necessarily require threat-related stimuli. An individual may perceive that there is a potentially dangerous threat and allocate attentional resource to detect the threat, which reduces attention to the ongoing task (Eysenck et al., 2007).

The main effects of worry occur in the central executive component of working memory. Because we have limited working memory attentional resources, when an individual worry, the resources available to devote to the current task will decrease. According to emotion control theory (Gross et al., 1997), humans tend to control anxiety and are motivated to minimize the level of worry. The attempt to control anxiety will also cost cognitive resources and occupy working memory, causing a decrease in available cognitive resources and lower the effectiveness and efficiency of the individual's work performance.

2.1.9 **Multitasking**

Szumowska and colleagues (2018) identified three categories of media multitasking research: patterns, motivations, and effects. Pattern studies focus on the characteristics multitasking; they seek to answer questions about when, what, and how media multitasking happens. Motivation studies focus on internal and external drives; they seek to answer questions about why people multitasking and their preferences. Effects studies focus on the outcomes by investigating the consequences of media multitasking, such as cognitive and social functioning.

This study will follow the research stream of effects studies to investigate the influence of distraction.

Szumowaka et al (2018) argued that multitasking performance is related to frequency of task switching only when behavior regulation is low. Self-regulation, also called self-control, is the ability to "control one's attention and behavior in relative autonomy from external pressures, innate and learned automatisms, and physiological impulses" (Szumowska et al., 2018, p.185). Self-regulation requires the ability to create and apply a schedule of tasks; it also requires rescheduling, abandoning irrelevant tasks, and adjusting strategies to achieve goals (Neal et al., 2017). The ability to ignore distractions and shift attention from interrupting activities, especially internally-triggered interruptions, is crucial to self-regulation (Adler & Benbunan-Fich, 2013; Katidioti, Borst, & Taatgen, 2014).

The consequences of multitasking have been reported in the IS literature. Research shows that when multiple tasks are carried out synchronously, our cognitive systems cannot process them effectively et al., 2009). When facing multiple tasks, attention resources are distributed across different tasks (Courage et al., 2015). Multitasking with information devices may cause individuals to ignore social or work activities (Zhang & Rau, 2016). Other research has found that media multitasking has a negative influence on academic performance (Rambe & Bere, 2013), cognitive functioning (Alzahabi & Becker, 2013), socioeconomic performance, and attention focus (Srivastava, 2013). Excessive multitasking is also associated with inattention, as well as the inhibition of planning, organizing, and task monitoring (Magen, 2017) Multitasking has also been associated with self-reported attentional failures and mind wandering but not self-reported memory failure (Ralph et al., 2014, 2015). Researchers have also found a significant positive correlation between media multitasking and the cognitive failures (Ralph et al., 2014).

Multitasking performance decreases when the frequency of multitasking increase (Ophir et al., 2009).

Frequent multitaskers are not capable of multitasking effectively because they are affected by the cognitive costs of switching between tasks (Ophir et al., 2009). In technology use, multitasking is a predominant behavior (Szumowska et al., 2018). People often hold a positive view toward multitasking and sometimes engage in multitasking in their daily lives. This positive view is justifiable because people have used multitasking to gain an advantage in both work and leisure; hence, they treat multitasking as a desirable skill (Monk, Trafton, & Boehm-Davis, 2008). Researchers have found that adolescents engage in more frequent media multitasking behavior and have more issues with attentional focus and control, inhibiting impulses and inappropriate behavior, and switching between tasks (Baumgartner et al., 2014).

People engage in media multitasking to varying degrees; studies show that occasional media multitaskers are different from frequent media multitaskers. Media multitasking has negative consequences for cognitive functioning, especially among those who engage in it frequently; they function lower than occasional multitaskers in key areas of cognitive control: task switching, filtering, and working memory use (Ophir, Nass, & Wagner, 2009). Recent research shows that frequent multitaskers have some common characteristics. For example, Ophir et al. (2009) also found that frequent media multitaskers have more difficulty than occasional media multitaskers in task switching and filtering out irrelevant, extrinsic stimuli. Frequent media multitaskers are more prone to distraction and immediate risks (Ophir, 2009). Other researchers (Przybylski et al., 2013) found that frequent media multitasking is associated with the fear of missing out (FOMO), while Fox, Rosen, and Crawford (2009) found it is associated with spending more time to complete given tasks. These findings support that the multitasker is not performance better in multitasking.

2.1.10 **Interruptions**

Interruptions have two characteristics: unexpected and prompt the cessation of the current task. Users temporally suspended the work at hand due to interruptions (Trafton et al., 2003; Weng et al., 2017). Researchers (Trafton et al., 2003; Weng et al., 2017) have suggested a model which describes how interruptions happen. In this model, the interruption is described in a time sequence. First, a distractor initiates the interruption. Next, the person attends to the interruption. Finally, after the interruption, the person resumes the primary task. In this process, there are two lags. The first is the interruption lag, which is the amount of time between the initial distraction and the person attending to it, and the second is the resumption lag, which is the amount of time between when the interruption ends and the primary task is resumed (Weng et al., 2017).

Researchers have found that interruptions create negative consequences such as decreased accuracy (Altmann & Trafton, 2015; Trafton et al., 2003), increased amount of time to complete a task (Addas & Pinsonneault, 2018; Altmann & Trafton, 2007; Hodgetts et al., 2015), and performance quality on complex tasks (Speier et al., 1999; Paul et al., 2015). Researchers have also explained these negative distraction effects. For example, Addas and Pinsonneault (2015) stated that IT interruptions can cause information overload. The time and energy costs of dealing with interruptions have adverse effects on productivity (Addas & Pinsonneault, 2015). Altmann and Trafton (2007) explained the increased task completion time by focusing on the time lag in the interruption process. They claimed that before resuming the primary task, users need to encode task-related information in working memory when the interruption initiates the distraction and retain this information during the interruption (Altmann & Trafton, 2015; Trafton et al., 2003). Dual-task interference (DIT) suggests that the human brain cannot perform multiple tasks simultaneously without a significant loss in performance even if all the tasks are simple (Jenkins et al., 2016). Distraction confluence theory explains that the attentional conflict between primary and secondary tasks can be caused by unpredictable events, which are interruptions. The attentional conflict increases arousal, which improves performance on a simple task. However, it also causes cognitive load, which impairs performance on complex tasks (Addas & Pinsonneault, 2018; Baron, 1986; Speier et al., 1999).

Researchers have also found positive effects of interruptions; Addas and Pinsonneault (2018) found that congruent interruptions are associated with a higher subjective workload and positively associated with performance effectiveness in terms of better decision-making performance, higher perceived performance, and better learning. They also found that interruptions negatively impact performance on simple or short tasks but have less impact on complex or longer tasks. Furthermore, interruptions may provide useful information that potentially helps users complete their primary tasks more effectively (Addas & Pinsonneault, 2015). Jenkins et al. (2016) point out that system-generated alerts could potentially be helpful to users. These alerts could be an interruption to users because the security message often blocks users from completing their primary tasks (Jenkins et al., 2016)

Because the interruption effect is sometimes positive and sometimes negative, distinguishing between distinct types of interruptions is helpful. A taxonomy comprising various types of interruptions can clarify when a positive or negative effect is likely to happen (Addas & Pinsonneault, 2015). In 2015, Addas and Pinsonneault differentiated IT interruption based on content relevance for primary tasks (i.e. relevant or irrelevant) and content structure (i.e. informational, actionable, or system). In their later research, they categorize distractors or interruptions into two groups, congruent and incongruent (Addas & Pinsonneault, 2018). Congruent means the distractor is relevant to the primary task but has no direct bearing on performing the primary task, while incongruent means the distractor is irrelevant to the primary task. When the distractor is relevant to the primary task, the distraction has a positive indirect effect through mindfulness; otherwise, the distraction has a negative effect by increasing the workload (Addas & Pinsonneault, 2018).

In many studies, interruption experiments have been conducted in laboratory settings where factors related to the interruption process can be controlled (Altmann & Trafton, 2007, 2015; Drews & Musters, 2015; Hodgetts et al., 2015; Monk et al., 2008). However, in the work environment, users have some strategies to manage interruptions (Weng et al., 2017). Users can select a strategy to handle the interruption, which means that the interruption can be only partially completed when the user resumes primary activities (Addas & Pinsonneault, 2018). For example, a user is interrupted by an email and may decide to respond to the email after completing the primary task (Weng et al., 2017). Also, in the work environment, the systems developer can control the influence of distractions. Jenkins et al. (2016)investigated system-generated alerts. Users often dismiss these alerts (Jenkins et al., 2016). However, the secondary task (i.e. the alerts) is very important, failing to handle the alert can cause potential issues. These alerts can increase users' stress and impair productivity. Hence, they suggest managing the timing of interruptions to mitigate the effect of DTI and enhance productivity on secondary tasks. They found that DTI decreases when a security message follows immediately after a task instead of interrupted a task, and this finding has been used by developers (Jenkins et al., 2016).

Multitasking and interruption have so many similarities. For example, both multitasking research and interruption research view working memory and the cognitive effort as two research areas, which could explain task performance decrease (Walter et al., 2015). Most of multitasking and interruption research are carried out in laboratory experiments setting and the findings may not be generalized to authentic situations. Some research even claim that interruptions are only "one form of the perhaps broader category of multitasking" (Janssen et al., 2015, p.3). Because of these similarities, researchers believe that compare distinct types of distraction effect can provide insights that are more than the sum of its parts (Janssen et al., 2015), and suggest to closing the gap between interruption research and multitasking research (Janssen et al., 2015).

After reviewing these findings, it is apparent that the mechanism underlying the impact distractions have on user performance has not been well investigated. This study attempts to fill the research gap and answer the following research question: How does task-irrelevant distraction interrupt users of information systems and influence their performance?

2.2 Research model and hypotheses development

Based on the previous discussion of distraction effects on user performance, working memory, cognitive load, anxiety, multitasking, and interruption, I propose that distraction is expected to negatively influence user performance and increase users' anxiety and cognitive load. A high cognitive load is expected to enhance the distraction effect on user performance. High anxiety is expected to enhance the distraction effect on cognitive load.

2.2.1 Distraction and task performance

An interruption is a special case of task switching, where the primary task is interrupted by a distractor and requires a resume, resulting in a cost of restart (Koch et al., 2018). Task performance is measured by the degree of task accuracy and the amount of time needed to complete the task ('task time'). A distraction interrupts the user's primary task and creates a disruption, which influences both task accuracy and task time. Bailey and Konstan (2006) found that interruptions will increase both the time spent to complete a task and the error rate, and Speier et al. (1999) found that a high frequency of interruptions decreases complex task performance as measured by task accuracy and task time.

Distractions increase task time by requiring additional time to not only solve the distractor but also to restart the primary task (Altmann & Trafton, 2007). After a distraction, users need to resume the primary task, which takes a varying amount of time. Monk et al. (2008) found that a more demanding distractor that requires a longer duration to resolve is associated with users needing a longer period of time to resume primary tasks. When users resume a task after an interruption, it takes briefer periods of time with practice, and if the users use the interruption lag to prepare to resume, they suffer fewer disruption effects (Trafton et al., 2003). The memory for goals model, which is also called the goal-activation model, explains this variation of the time spent on task associated with distraction effect (Altmann & Trafton, 2007). The model explains how individuals remember their goals when working on a task. It claims that goal-directed behaviors can be explained by memory mechanisms and associative priming. If a goal has been suspended and needs to be resumed, associative priming will retrieve it from memory, which takes time and effort (Altmann & Trafton, 2007). When the primary goal is interrupted by distractors, the memory will immediately begin to suffer activation decay. If goals decay for a long time, it causes the activation level to decrease. Also, a more demanding interruption will accelerate the activation decay, which may create a lower activation level for the same period (Altmann & Trafton, 2007). A goal with a lower activation level will take longer to resume (Altmann & Trafton, 2007); hence, when the distraction takes longer to handle, is more demanding, or both, it will result in the user taking a longer period of time to resume the primary task when there is no rehearsal.

Task performance is associated with processing resources (Norman & Bobrow, 1975). When distractions occur, the user will switch attention and effort between the primary task and distractors; hence, the distraction is a switching task activity. Rogers and Monsell (1995) used task-set reconfiguration and task-set inertia to explain why performance decreases when switching tasks (Rogers & Monsell, 1995). Users utilize a corresponding mental task set, such as task-relevant stimuli or stimulus-response mapping, to carry out a task (Rogers & Monsell, 1995). When users concentrate on their primary task, they do not expect a distraction. They are unable to react to it in a preset pattern, which is used to solve their primary task. To switch tasks, users must create a new mental task set in working memory, especially when the task switching is not in repeat trials. Thus, there is always a mental resource cost associated with switching tasks (Rogers & Monsell, 1995). When the distraction occurs, users need to allocate mental resources to reconfiguring the primary task before handling the distractor and then resume the primary task. This task-set reconfiguration activity will consume processing resources, which will limit the user's cognitive ability, causing decreased task performance. Based on these findings, I hypothesize the following:

H1: Distracted individuals will exhibit lower primary task performance than individuals who are not distracted.

2.2.2 Anxiety

Anxiety is "a state in which an individual is unable to instigate a clear pattern of behavior to remove or alter the event/object/interpretation that is threatening an existing goal" (Power & Dalgleish, 1997, pp. 206–207). When a secondary task interrupts the primary task, individuals will experience increased anxiety (Bailey, Konstan, & Carlis, 2001; Bailey & Konstan, 2006). Zijlstra et al., 1999) found that distractions negatively affect subjects' emotions and well-being and increase state anxiety as measured by Spielberger's State Anxiety Scale (Spielberger, 2010).

In the information systems context, distractions create anxiety by reducing the available time for completing the primary task. When users finish handling a distractor and return to their primary task, they will perceive greater time pressure because they have wasted time on secondary tasks (Speier et al., 1999). When the distractor originates from the same information system as the primary task, users must handle the distractor before continuing primary tasks. In this case, users waste time on the distractor. Because the time pressure is then increased, users experience anxiety (Eysenck, 1985; Eysenck et al., 2007; Miller, 1960). In the work environment, information system users typically have a limited amount of time to decide how to respond to the distraction; hence, they will suffer from a higher level of distraction-related stress when available time is reduced (Kalsbeek, 1964), which is associated with higher level of anxiety (Baron, 1986, Eysenck et al., 2007). Based on these findings, I hypothesize that:

H2: Distracted individuals perceive higher levels of anxiety than individuals who are not distracted.

2.2.3 Cognitive load

Cognitive load theory states that the cognitive load depends on the interaction between the demands on working memory resources and the individual's cognitive capability (Paas et al., 2003), and increasing the demands on working memory will increase the cognitive load. Distractions potentially cause information overload by taking time away from the primary task and increasing the task processing demands (Norman & Bobrow, 1975; Speier et al., 1999).

When a distraction occurs, the user shift attention between the distraction and the primary task, which updated their working memory (Eysenck et al., 2007; Miyake et al., 2000). When the user shifts attention to distractors, the control executive function of working memory is actively shifting and updating (Miyake et al., 2000). These behaviors require working memory resources, which increases task-processing demands. Hopko, Ashcraft, Gute, Ruggiero, and Lewis (1998) measured participants' ability to inhibit attention to distracters and the effects of this ability on explicit memory performance. They found that task-irrelevant distracters consume working memory resources and cause a deficient inhibition mechanism (Hopke et al., 1998). The distraction disrupts users' cognitive processes related to the primary task and occupies working memory (Baron, 1986). Also, the distraction can create attentional conflict between the primary task and the secondary task, which increases task-processing demands (Baron, 1986; Eysencl et al., 2007). Based on these findings, I hypothesize the following:

H3: Distracted individuals perceive higher levels of cognitive load than individuals who are not distracted.

2.2.4 Effect of anxiety on cognitive load

Anxiety is one emotional response to distraction, which may happen because of increased time pressure. Anxiety influences the cognitive load by influencing the attention system and attention control source. According to attention control theory, anxiety will increase the level of worry and influence the center executive function in the attentional control system (Eysenck & Derakshan, 2011). Anxiety negatively affects the goal-directed attention system's functioning and increases the individual's attention to threat-related stimuli (Eysenck et al., 2007). Eysenck (1985) found anxiety affects performance on a complex version of the letter transformation task and claimed that anxiety influences the rehearsal and storage of task-relevant information. In the context of distractions, anxiety increases the influence of stimulus-driven systems, which respond to the distractor and decreases the influence of goal-directed systems, which is the primary task (Eysenck et al., 2007). Because the attention shifts to the distractor, users will allocate more working memory resources to the distractor. When the primary task's mental requirements stay the same, an anxious individual will experience more cognitive load.

Anxiety influences cognitive processes by influencing the attentional control source, in terms of deficient recruitment resource and inefficient use of resource (Eysenck & Derakshan, 2011). Anxiety influences the inhibition function and shifting function of central executive systems (Eysenck et al., 2007; Eysenck & Derakshan, 2011), which influence the use and recruitment of the attentional control system. Eysenck and Derakshan (2001) found that the deficient recruitment of resource is likely to happen when motivation to complete a task is low, and the inefficient use of resource is likely to happen when motivation to complete a task is high. Because the recruitment and the use of the attention control system will be more difficult when the user feels anxious, the user may suffer more cognitive load if distractions cause them to feel anxious. Based on these findings, I hypothesize the following:

H4: Anxiety will moderate the influence of distraction on cognitive load.

2.2.5 **Effects of cognitive load on task performance**

According to cognitive load theory, there are three types of loads: intrinsic, extraneous, and germane cognitive (Paas et al., 2003). The intrinsic load is "determined by an interaction between the nature of the material being learned and the expertise of the learners" (Pass et al., 2003, p. 65), while the extraneous cognitive load is "the extra load beyond the intrinsic cognitive load resulting from mainly poorly designed instruction" (Pass et al., 2003, p. 65), and germane cognitive load is "the load related to processes that contribute to the construction and automation of schemas" (Pass., 2003, p. 65). Schaap et al. (2018) used cognitive load theory to explain the consequence of media multitasking and found that media multitasking with a second screen will lead to impaired information retrieval. This decreases the performance of information recall and is influenced by high intrinsic cognitive loads, which is determined by the complexity of the recall task. If multiple concurrent tasks require the same working memory resources to encode, store, and retrieve information, resources will be distributed across tasks, ultimately resulting in diminished cognitive performance (Schaap et al., 2018). Furthermore, multitasking's influence on different types of task performance varies based on the level of multitasking (Alzahabi & Becker, 2013; Baumgartner et al., 2014; Ophir et al., 2009) and the task type (Baumgartner et al., 2014) because the cognitive load varies under different situations.

When users are engaged in a primary task, then interrupted by a distractor, which is a secondary task, users return to the primary task after resolving the distractor; this is a form of sequential multitasking (Trafton et al., 2003). The only difference between interruption and other types of multitasking is that the lower performance is associated with the extraneous load in the interruption situation, because the secondary task, the distractor, involves unnecessary information processing of the primary task; while the decreased performance of other types of multi-tasking is caused by the intrinsic load, because both primary and secondary tasks are important tasks for users. Based on these findings, I hypothesize the following:

H5: Cognitive load will moderate the distraction effect on task performance.

2.2.6 Mandatory Interruption Versus Discretionary Multitasking

In the work environment, individuals can be distracted by four types of interruptions: intrusion, breaks, distraction, and discrepancy (Jett & George, 2003). Two of these describe a situation where a unexpected stimulus interrupts the performance of a primary task, for example, when something unexpected interrupts the flow and continuity of an individual's work and brings the work to a temporary halt (Jett & George, 2003, p.495). Another example is when competing activities or environmental stimuli that are irrelevant to the task at hand affect a person's cognitive processes by diverting attention that might otherwise have been directed to that task (Jett & George, 2003, p.500). Both situations can distract individuals and influence their work performance, and the potential consequences of these two types of distractions are different (Jett & George, 2003). In this research, the first situation is referred to as a ‘mandatory interruption’ and the second situation is referred to as a ‘discretionary multitasking’. Mandatory interruptions and discretionary multitasking are both theoretically important (Adler & Benbunan-Fich, 2015). The difference is that individuals who engage in discretionary multitasking control the when and how of interruptions to the primary task, while individuals who encounter mandatory interruptions do not have any control over how the distractor should be handled (Adler & Benbunan-Fich, 2015).

When encountering a mandatory interruption, the individual experiences a heightened feeling of stress and anxiety as he or she recognizes that less time is available, especially when the individual has a sense of urgency about completing primary tasks (Jett & George, 2003). Interruptions disrupt the person's state of total involvement in the primary task (Jett & George, 2003). The total involvement state is called state of flow, which occurs when individuals are fully motivated and actively engaged in a task without a sense of time consciousness (Csikszentmihalyi, 1990). Csikszentmihalyi describes the state of flow as situations “in which people are so involved in an activity that nothing else seems to matter" (Csikszentmihalyi, 1990, p. 4). The four dimensions of the state of flow include intense concentration, a sense of being in control, a loss of self-consciousness, and the transformation of time. When an interruption occurs, the individual is forced to temporally disengage their primary task, which breaks concentration and the sense of being in control and pulls the individual out of the state of flow. When leaving the state of flow, the individual feels the time pressure, especially when the primary task is important to them (Jett & George, 2003).

In the discretionary multitasking situation, individuals shift their attention to the secondary tasks. They may still be in the state of flow when they are multitasking and not experience the stress and anxiety associated with the heightened feeling of time pressure. Unlike the interruption situation, the discretionary multitasking situation may not force individuals to leave the state of flow because multitasking individuals may still have intense concentration and a sense of being in control when they shift their concentration to the secondary task. Because discretionary multitaskers may still be in the state of flow, they feel less time pressure than individuals in the interruption situation. For this reason, I hypotheses the following:

H6: Multitasking individuals experience less anxiety than individuals who experience mandatory interruptions.

2.2.7 **Selective Attention**

Selective attention allows individuals to only process some selected information while ignoring other information (Durso, Nickerson, Dumais, Lewandowsky, & Perfect, 2007), which enables individuals to not become overwhelmed by irrelevant information. When distractions occur, individuals can choose not to process all the information in the secondary task because they have selective attention. Distractions influence the user's cognitive load because they require mental resources to process the information (i.e. the distractor). If users ignore part of the information, the distraction's influence may decrease. The effective inhibition function of the center executive can enhance selective attention and keep the distraction out of working memory (Eysenck et al., 2007); otherwise, the distraction will increase the mental workload.

In a mandatory interruption situation, individuals must complete the secondary task before continuing. They must immediately shift attention away from the primary task and focus on the secondary task until it is completed. Because the secondary task must be completed, users cannot use selective attention to only process part of the information; they must concentrate fully on the secondary task. Hence, it has been suggested that mandatory interruptions are harmful to the extent they disrupt individuals' focused attention on a task (Adler & Benbunan-Fich, 2015; Jett & George, 2003).

Conversely, in a discretionary multitasking situation, individuals can choose when to respond to the secondary task. In fact, individuals prefer to shift attention at a low cognitive-load point (Salvucci & Bogunovich, 2010), which may minimize the negative effects of a disruption (Bailey & Iqbal, 2008) by decreasing the likelihood of information overload and lessening the impact of attention conflict; the user may also perceive a lower cognitive load. Furthermore, before switching to the secondary task, selective attention may enable the individual to reduce the influence of distraction. Thus, discretionary multitasking does not increase cognitive load as much as a mandatory interruption, and I hypothesize the following:

H7: Multitasking individuals perceive a lower level of cognitive load than individuals who experience mandatory interruptions.

Mandatory interruptions and discretionary multitasking influence users' performance differently under different situations (Adler & Benbunan-Fich, 2013). The negative impact of distractions on performance is associated with the switching cost between the primary task and the secondary task (Eysenck et al., 2007). Under the discretionary multitasking condition, individuals can decide when and how to switch between primary and secondary tasks. The individuals can choose to respond to the distractor when mental load is minimal to reduce the conflict of mental resource requirements (Janssen, Brumby, & Garnett, 2012); this time point is called a ‘natural break point’ (Janssen et al., 2012), which enables individuals to minimize their switch cost and enhance performance. Under the mandatory interruption situation, individuals lack control over the interruption and experience greater distraction effects. Hence, task switching is unlikely to happen at the natural break points, so more effort is required to switch tasks, and individuals in the mandatory interruption condition will perform worse than those in the discretionary multitasking condition. Therefore, I hypothesize the following:

H8: Multitasking individuals perform better than individuals who experience mandatory interruptions.

CHAPTER III

METHOD

3.1 Experiment Design

To test the model proposed in Chapter II, I used a classical 3*1 experimental design. Each participant is assigned to one of three groups: the control group, experimental group A, and experimental group B. Using a laboratory setting, I tested the phenomenal of distraction. In the experiment, participants completed data analysis questions in the "Milo" system, which recorded their eye movement, facial expressions, and performance; then, they answered a brief survey about anxiety and cognitive load.

3.2 Experimental Procedure

All participants were recruited from Mississippi State University. In the experiment, participants are asked to answer a series of data analysis questions and a brief survey using the Milo system in a lab setting. The data analysis tasks are presented on a computer and involve the participants selecting the correct answers to questions based on the information presented in a set of graphs. After answering all the data analysis questions, the participants complete a survey, which is used to capture their anxiety level and cognitive load. The survey was designed using Qualtrics and presented in the Milo system. The participants complete the experiment individually in the lab to minimums the unexpected effect of other distractions or social influence.

The lab used for the experiment is a 5 * 5-meter space. Participants sit in front of a desktop computer and monitor with an attached camera (Figure-in process). In the lab, there are three stations available. To prevent participants from influencing each other, only the middle station is used to collect data.

To prevent interaction effects due to selection bias, participants were randomly assigned to a group. Random assignment enhanced the study's internal validity because all confounding variables are distributed across all three groups, which ensures that differences between groups are caused by the experimental condition. Performance levels and distractions are behavior data, which are directly captured. Anxiety and cognitive load are latent variables, which are adapted from previous research.

In the experiment, the participants receive verbal instructions about the Milo system and analysis questions; they are all asked to read and confirm an informed consent form before beginning. The verbal instructions are consistent across all three groups. When performing the data analysis task, all participant answer each question based on a data graph (see Figure 1 for an example.). Participants can only view each question one time. After they complete the data analysis task, a survey appears on the screen. When they complete the survey, the experiment is completed. Each participant is allowed up to 15 minutes to finish the entire process.

3.3 Manipulation

A distraction is used as a manipulation in group A. In this group, the distraction acts as an external stimulus, and participants must passively respond to the stimulus before continuing their task. The distraction is a pop-up message (see Figure 1). After the participant has been working on the 13th question for 10 seconds, the distraction page will automatic pop-up and block the screen. The participants must follow the instructions on the distraction page, which asks them to click the Shift + Space key to get rid of the pop-up window and continue their task.

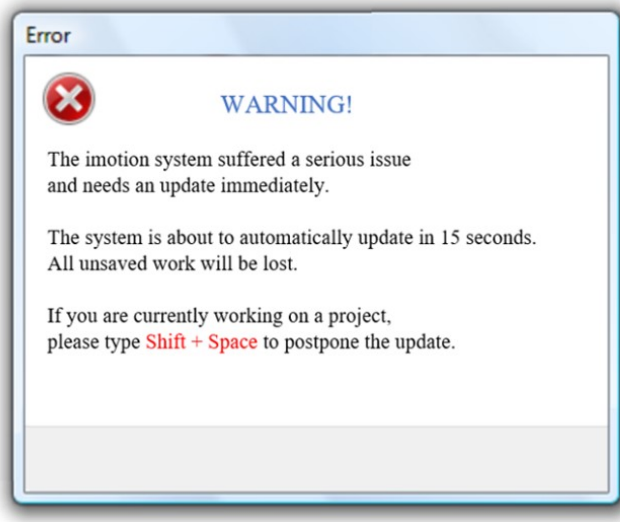

Figure 3.1 Pop-up message

A multitasking requirement is used as manipulation in group B. In this group, the distraction acts as an external stimulus. The difference between group A and group B is that the participants know that there will be a secondary task and decide when to respond to the secondary task. The manipulation involves the researcher personally asking the participant to sign a paper-based consent form (see Figure 1) after the participant has been working on the 13th question for 8 seconds. The form's content is similar to the consent form they already signed at the beginning of the study, and the participants decide when to sign it during the experimental condition. The iMotions facial recording can be used to determine whether the participant reads the form.

No other processes were used on the control group in the experiment.

Consent Form for Participation in Research

Thank you for agreeing to participate in our research. Before you begin, please note that the data you provide will be store in an encrypted fold, only researchers in this study can access it. Additionally, this research is for residents of the United States over the age of 18.

You research may be able to link your responses to your ID in ways that are not bound by this consent form and the data confidentiality procedures used in this study.

Researchers: Ziyi Niu, Mississippi State University;

This experiment will take about 15 minutes to complete.

Questions: If you have any questions about this research project, please feel free to contact Ziyi Niu at zn52@msstate.edu.

Voluntary Participation

Please understand that your participation is voluntary. Your refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. You may discontinue your participation at any time without penalty or loss of benefits.

If you agree to participate in this research study, please Sign below:

Participant Signature: ______________________________

Researcher Signature: _____________________________

Date____

Figure 3.2 Manipulation

3.4 Tools for Measurement

During the experiment, participants answer data analytics-type questions using a system named Milo, which is an eye movement and facial expression-capture system. It uses eye tracking hardware (Tobii X60) and iMotions software (version#) to assess visual attention measured by gaze and fixation characteristics.

iMotions software is used to recognize and analyze participants' expression of emotions. The iMotions software records users' facial expressions using ten metrics: three overall emotional valences, including positive, negative and neutral, and the seven basic emotions, which are joy, anger, surprise, fear, contempt, sadness, and disgust.

iMotions systems use an AFFDEX engine to identify faces and locate the 33 main feature points on the face (see Figure). It assesses facial movements, as well as the shape and texture of the face at the pixel level (iMotions, 2017). It can record 15 emotion channels: smile, brow furrow, brow raise, lip corner depressor (frown), inner brow raise, eye closure, nose wrinkle, upper lip raise, lip suck, lip pucker, lip press, mouth open, lip corner depressor, chin raise, and smirk (iMotions, 2017).

The iMotions software records participants' emotion score in two formats, graphical and numerical (Figure); the numerical score is also called 'evidence.' The evidence output tells us the odds, on a logarithmic base 10 scale, that a specific emotional expression is presented. Using the 'joy' as an example, evidence value 1 means that the observed expression is 10 times more likely to be categorized as joyful than not joyful, while evidence value 2 means that the observed expression is 100 times more likely to be categorized as joyful than not joyful, and evidence value 0 means the expression has an equal chance of being categorized as joyful or not joyful. (iMotions, 2016; Krouwer & Poels, 2017)

3.5 Measurement

To investigate the influence of distraction on users' behaviors, the following theories were used as the underlining theoretical foundation for this research: memory for goal theory, processing efficiency theory, attentional control theory, cognitive load theory, working memory theory, distraction conflict theory, and resource matching theory. Four constructs are used in this research: distraction, anxiety, cognitive load, and task performance. Two constructs, anxiety and cognitive load, are physiological measures. The other two constructs, distraction and task performance, are direct measures of behavior.

3.5.1 **Anxiety**

Anxiety can be a state or a trait construct (Spielberger, 2010). In this research, anxiety refers to a state and is defined as “a state in which an individual is unable to instigate a clear pattern of behavior to remove or alter the event/object/interpretation that is threatening an existing goal” (Eysenck et al., 2007). Previous research has found that the both saccade rate and self-report anxiety consistently reflect individuals’ anxiety level (Tichon et al., 2014). Because the focus of this study is distraction, self-reporting would itself cause distraction and influence the manipulation. We thus used an objective measurement, saccade rate, as a more valid way to measure the anxiety level.

According to previous research, a higher saccade rate indicates a higher level of anxiety (Tichon et al., 2014). The iMotions system does not directly measure the saccade rate, but it does measure the fixation rate, which is the percentage of time spent on fixation. Saccade is defined as a quick eye movement that separates fixations (Ahn, Bae, Ju, & Oh, 2018; Zou & Ergan, 2019). Saccade rate can thus be calculated as the total number of saccades divided by the time spent on a task in seconds (Lagun & Agichtein, 2014). Based on these definitions, the saccade rate is calculated as one hundred minus the fixation rate in percent.

3.5.2 **Cognitive load**

Cognitive load is a multidimensional construct representing the load that a particular task imposes on the performer (Paas et al., 2003). Joseph et al. (2013) compared three types of measurement, a self-report rating of cognitive load, physiological measures, and an objective physiological measure, and established the validity of all those three measurements. To prevent the influence of self-reporting on manipulation, we used physiological measures to measure the cognitive load.

Researchers use varying types of physiological measurement of cognitive load, one of which is eye fixation (Behroozi et al., 2018; Gould, 1973; Krejtz et al., 2018). Research has found that an increase in fixation durating is associated with load level increase (Gould, 1973). The fixation time was collected by iMotions.

Gaze point is a raw sample captured by the eye tracker. The iMotions system uses Tobii eye tracker, which has a collection rate of 30HZ, meaning that it collects gaze points 60 times a second and each gaze point represents a sixtieth of a second (or 33.33 milliseconds; Farnsworth, 2018). Fixation is gaze cluster, or a series of gaze points that are very close in time and space (Farnsworth, 2018). When eyes smoothly track an object at a speed below 30° per second, this creates a fixation point; otherwise, saccades are generated (Farnsworth, 2018). The iMotions system measured the total time spend on fixation, which indicates cognitive load.

3.5.3 **Distraction**

These are measured by actual behaviors. The study aims to compare the users' performance in three groups: 1) the control group, 2) distraction group A, and 3) distraction group B. The distraction is a dummy code (i.e. 1,2, and 3) to represent these three groups.

Performance was directly measured as participants' accuracy divided by the time spent on the data analysis questions after the distractions.

3.5.4 **Performance**

Performance has two dimensions, accuracy and time. Higher accuracy indicates better performance, as does less time spent on a task. Two items are collected to measure users' performance: first, the accuracy of each user's answer. If a participant provides the correct answer to the question, their accuracy is 1, otherwise it is 0. The second item is the time spent on the primary tasks, measured in seconds. The iMotions system records the time each user takes to complete a question in milliseconds; in this study, that time was recorded to the millisecond, although for analysis, the time was converted into seconds to ensure the results interpretation had more practical implementation.

Table 3.1 Variable definitions

Variable	Definition	Source
Anxiety	A state in which an individual is unable to instigate a clear pattern of behavior to remove or alter the event/ object/interpretation that is threatening an existing goal."	Power & Dalgleish, 1997, pp. 206–207; Eysenck et al., 2007
Cognitive load	Cognitive load is a multidimensional construct representing the load that a particular task imposes on the performer.	(Paas et al., 2003)
Performance	The quality of task performance indexed by standard behavioral measures.	Eysenck et al., 2007

3.6 iMotions measures

The distraction and task performance are behavioral data collected by iMotions. The performance is calculated by the accuracy divided by time spent on the task. Accuracy is calculated as the number of correctly answered questions divided by the total number of questions the participant answered (Adler & Benbunan-Fich, 2013). Time is measured in seconds and only includes the time participants spent answering the analysis questions. The task time begins after participants first fixate on the questions. It does not include the time participants spent on distractions. The task time also does not include the time spent on calibration, reading the consent form, responding to the distraction message, and multitasking on signing the paper-based form. The camera recordings of facial expressions also indicate when and whether the participant pays attention to working on the secondary task.

3.7 Considerations of the Design

One consideration of the design is the learning effect. The tasks are graphic analysis questions. The participants are asked to read the graphs and answer questions based on the information on the graph. Because participants have different levels of ability to solve this type of question, the first 12 questions, which are presented before the distraction, help participants learn how to solve these questions and include all the possible types of questions and graphs used in this study. After solving the first 12 questions, participants should be able to solve all the questions after the distraction.

The manipulation in this research is the participants' attention. If the participant does read the distractive material and shift their attention away from the primary task, it means that the manipulation works. The iMotions systems recorded the participants' behaviors, which can be used to support manipulation check. Also, at the end of the survey, a manipulation check question, "How distracted were you" is asked to all groups to ensure the strength of the treatment between groups.

3.8 Data Analysis Method

In order to estimate the sample size needed to test for hypotheses, a statistical tool G*Power is used to conduct a power analysis. According to G*Power (Faul et al., 2009; Faul, et al., 2007), the total required sample size to examine the differences between the two groups using analysis of variance tests with an effect size of 0.25, alpha of 0.05, and power of 0.80 is 128 responses, or 43 per group. To determine differences between groups, group means were compared for any differences using SPSS 24. See results of the analysis in Chapter IV.

Table 3.2 Data analysis method

Hypotheses	Analysis method
H1: Distracted individuals will exhibit lower primary task performance than individuals who are not distracted.	One-way ANOVA
H2: Distracted individuals perceive higher levels of anxiety than individuals who are not distracted.	One-way ANOVA
H3: Distracted individuals perceive higher levels of cognitive load than individuals who are not distracted.	One-way ANOVA
H4: Anxiety will strengthen the influence of distraction.	3*3 Factorial ANOVA
H5: Cognitive load will strengthen the distraction effect on task performance.	3*3 Factorial ANOVA
H6: Multitasking individuals experience less anxiety than individuals who experience mandatory interruptions.	One-way ANOVA
H7: Multitasking individuals perceive a higher level of cognitive load than individuals who experience mandatory interruptions.	One-way ANOVA
H8: Multitasking individuals perform better than individuals who experience mandatory interruptions.	One-way ANOVA

CHAPTER IV

DATA ANALYSIS AND RESULTS

This section will evaluate the hypotheses of this study. The analysis is conducted using the objective measurement of eye movements using the iMotions system. The variables for the research are: (1) distraction group, which used a dummy variable with control group = *1*, multitasking group = *2*, and mandatory distraction group = *3*; (2) cognitive load, measured using time spent on gazing in seconds; (3) anxiety, measured using percentage of time spent on saccade; (4) time spent on task in seconds; and (5) accuracy, whether the primary task was answered correctly. SPSS version 24.0 (IBM Corp., 2012) was used for hypothesis testing and preliminary and post-hoc data analyses. Several one-way analyses of variance (ANOVAs) were conducted to test the influence of distractions on user performance. Cognitive load and anxiety are also additionally measured using the metrics recorded by the iMotions.

4.1 Hypothesis Tests

Table 4.1 shows the correlation between constructs of main study. Figure A1 in Appendix A shows the output page in SPSS.

Table 4.1 Correlation test

	Distraction	Accuracy	Time	Anxiety	Cognitive load
Distraction	-				
Accuracy	.021	-			
Time	.299*	.169	-		
Anxiety	-.064	-.118	.150	-	
Cognitive Load	.246*	.055	.369*	-.622*	-

* significant at the .05 level.

H1 proposed that task performance would change as a function of distraction. More specifically, it predicted that task performance would be better in undistracted individuals than in distracted individuals. Performance has two dimensions, accuracy and time. Higher accuracy indicates better performance, as does less time spent on a task. ANOVA was carried out to test whether there is a significant difference in participants' performance in term of time and accuracy.

The results of a one-way ANOVA showed that there is no statistically significant difference in the effect of distraction on the accuracy with which participants performed the task (F [2, 124] = .072, p = .931). Participants in the control condition (n = 43, M = .72, SD = .45) showed a similar accuracy rate for the primary task as those in the mandatory distraction condition (n = 43, M = .72, SD = .40) and in the multitasking condition (n = 41, M = .74, SD = .44). Furthermore, the assumption of homogeneity of variances was tested and satisfied based on Levene's F test (F [2, 124] = .293, p = .747). Figure A2 in Appendix A shows the output page from SPSS.

The results of a one-way ANOVA showed there was a significant effect of distraction on time spent on task (F [2, 124] = 7.262, p = .001). Participants in the control condition (n = 43, M = 38.802, SD = 17.986) spent less time on the primary task than participants in the mandatory distraction condition (*n* = 43, *M* = 53.516, *SD* = 18.819) and in the multitasking condition (*n* = 41, *M* = 51.536, *SD* = 21.292). Furthermore, the assumption of homogeneity of variances was tested and satisfied based on Levene's *F* test (*F* [2,124] = .319, p = .728). The data supported H1. Figure A3 in Appendix A shows the output page in SPSS.

H2 predicted that distracted individuals would be higher in anxiety than undistracted individuals—the distraction would increase the anxiety level. Previous research has found that the saccade rate consistently reflect individuals' anxiety level (Tichon, Wallis, Riek, & Mavin, 2014). We used saccade rate to measure the anxiety level.

H2 predicted that distracted individuals would have a higher saccade rate and a lower fixation rate than undistracted individuals. The fixation rate was collected by iMotions, with a data set of 117 eye tracking measurements successfully collected. The results of a one-way ANOVA showed that there was a significant effect of distraction on anxiety (*F* [2, 114] = 7.756, *p* = .01). Participants in the control condition (*n* = 36, *M* = 37.222, *SD* = 15.053) had a higher saccade rate than those in the mandatory distraction condition (*n* = 40, *M* = 39.622, *SD* = 15.208) and multitasking condition (*n* = 41, *M* = 49.37, *SD* = 13.249). The assumption of homogeneity of variances was tested and satisfied based on Levene's *F* test (*F* [2, 114] = .332., p = .718). The data supported H2. Figure B in Appendix A shows the output page from SPSS.

H3 hypothesized that distraction would increase the cognitive load. Research has found that an increase in fixation is associated with cognitive load increase (Gould, 1973). H3 predicted that distracted participants would suffer a higher cognitive load than undistracted individuals, thus predicting that the distraction group would spend more time on fixation.

The results of a one-way ANOVA showed that there was a significant effect of distraction on fixation time spent on task (*F* [2, 124] = 4.013, *p* = .021). Participants in the undistracted group (*n* = 36, *M* = 24.137, *SD* = 11.576) spent less time on fixation than those in the mandatory distraction condition (*n* = 40, *M* = 31.856, *SD* = 13.563) and multitasking condition (*n* = 41, *M* = 29.703, SD = 11.217). Furthermore, the assumption of homogeneity of variances was tested and satisfied based on Levene's *F* test (*F* [2,114] = 4.013, p = .021). The data supported H3. Figure C in Appendix A shows the output page from SPSS.

H4 predicted that anxiety had a moderating effect on the path of distraction to cognitive load. An ANOVA with an interaction term for anxiety by distraction was performed to test this hypothesis. The sample of 117 data sets was evenly split into three groups with different levels of anxiety, measured by the saccade rate as described above. The 39 data with the highest fixation rates and lowest saccade rates were denoted *anxiety group 1*, the 39 with the next lowest fixation rates and next highest saccade rates were denoted *anxiety group 2*, and the rest were denoted *anxiety group 3*. The cognitive load was measured by the time spent on fixation.

A two-way ANOVA with the interaction terms of anxiety (high, mid, low) and distraction group (no distraction, multitasking, mandatory interruption) showed that there was no statistically significant interaction between groups (*F* [4, 108] = .194, *p* = .941). In addition, the assumption of homogeneity of variances was tested and satisfied based on Levene's *F* test (*F* [8, 108] = .934, *p*= .492). This finding does not support H4. Figure D in Appendix A shows the output page from SPSS.

H5 proposed that there is an interaction effect of cognitive load and distraction on task performance. The sample of 117 data sets was evenly split into three groups with different levels of cognitive load, measured by fixation time. The 39 data with the shortest fixation times were denoted *load group 1*, the 39 with the longest fixation time were denoted *load group 3*, and the rest were denoted *load group 2*.

Two two-way ANOVAs with the interaction terms of cognitive load level (high, mid, low) and distraction group (no distraction, multitasking, mandatory interruption) showed that there was no statistically significant difference between groups in terms of both task time (F [4, 118] = 1.313, p = .269) and task accuracy (F [4, 108] = .759, p = .554) This finding supports H5. Figure E in Appendix A shows the output page from SPSS.

H6 hypothesized that multitasking individuals would suffer less anxiety than individuals who experienced mandatory interruptions. Anxiety was measured by saccade rate. One-way ANOVA showed that there was a statistically significant difference between multitasking individuals (n = 41, M = 49.366, SD = 13.249) and mandatory interruption individuals (n = 40, M = 39.622, SD = 15.208) in terms of anxiety (F [1, 79] = 9.466, p = .003). The assumption of homogeneity of variances was tested and satisfied based on Levene's F test (F [1, 79] = .655, p = .421). This finding does not support H6. Figure F in Appendix A shows the output page from SPSS.

H7 predicted that multitasking individuals would perceive a lower level of cognitive load than mandatory interruption individuals. A One-way ANOVA was conducted. The result showed that there is no statistically significant difference between multitasking individuals and mandatory interruption individuals in term of cognitive load (F [1, 79] = .608, p = .438). The assumption of homogeneity of variances was tested and satisfied based on Levene's F test (F [1, 79] = .365, p = .547). This finding does not support H7. Figure G in Appendix H shows the output page from SPSS.

H8 predicted that multitasking individuals have better performance than mandatory interruption individuals. Performance included two dimensions, time and accuracy. Two one-way ANOVAs showed that the mandatory distraction group had a higher accuracy (n = 40, M =

.75, *SD* = .439) than the multitasking group (*n* = 41, *M* = .707, *SD* = .461). Moreover, the mandatory distraction group spent more time (*n* = 40, *M* = 52.659, *SD* = 18.631) than did the multitasking group (*n* = 41, *M* = 51.536, *SD* = 21.292). However, there is no statistically significant difference between multitasking individuals and mandatory interruption individuals in term of time spent on task (F [1, 79] = .064, p = .801) or accuracy of task (F (1, 79) = .182, p = .671). This finding does not support H8. Figure H in Appendix A shows the output page from SPSS.

4.2 Interpretation of the Results

A total of eight hypotheses were tested in the study. Evidence was found to support three of these hypotheses. The relationship proposed by a sixth hypothesis did have a significant *p*-value but was in the opposite direction to that expected. In this section, the results are interpreted.

H1 predicted that distracted individuals will exhibit lower primary task performance than individuals who are not distracted. The data shows that the distracted individuals spent more time on the primary task, although the accuracy of their answers was similar to that of the undistracted individuals. According to process efficiency theory, individuals can adjust the time spent on a task and its effectiveness while keeping efficiency constant (Eysenck & Calvo, 1992). The efficiency of an individual will be lower when distracted; hence, the participant has to decide either to spend more time or have reduced output quality. In this study, the individuals decided to spend more time to maintain accuracy. On average, to finish the same question as undistracted individuals with similar accuracy, participants spent an extra 12.73 seconds in the multitasking condition and an extra 14.71 seconds in the distraction condition. This finding supports H1's assertion that distraction would lower overall primary task performance.

H2 predicted that distraction would increase anxiety. The findings show that there was an increase in the saccade rate after distraction, which indicates that participants suffered an increase in the anxiety level after a distraction. Attentional control theory suggests that distraction increases anxiety because it influences the function of the attentional control system (Eysenck & Derakshan, 2011). This study used eye movement data to confirm the anxiety increase after distraction. The undistracted individuals had lower saccade rates than both multitasking and mandatory distraction participants. This finding suggests that distraction does increase anxiety, which supports H2.

H3 predicted that distraction would increase cognitive load. Cognitive load theory suggests there are three types of cognitive load, intrinsic, extraneous, and germane (Paas et al., 2003). Distraction increased the intrinsic and extraneous loads and increased the demand on working memory resources. The distraction thus increased the cognitive load. The data showed that the distracted participants spent more time in fixating on the area of interest, which previous research has shown is an indicator of cognitive load (Behroozi et al., 2018; Marandi, Madeleine, Omland, Vuillerme, & Samani, 2018). This finding suggests that distraction increased the cognitive load and thus supports H3.

H4 predicted that anxiety would moderate the effect of distraction on cognitive load. Attentional control theory suggests that anxiety influences the cognitive process by creating deficiencies in the recruitment of resources and inefficient use of resources (Eysenck & Derakshan, 2011). The deficient recruitment and inefficient use of resources increases the total amount of working memory resources needed to complete a task, which increases total cognitive load. However, this analysis did not support the moderating effect of anxiety on the relationship between distraction and cognitive load. One plausible explanation is that the influence of anxiety is associated with the use of working memory resources (Eysenck et al., 2007) and resource use is controlled by the individual. In this study, the primary task was a multiple-choice question; hence, participants were able to provide any answer when they just wanted to move to the next question. Individuals use avoidance and escape behaviors to control anxiety (Sege, Bradley, & Lang, 2018). In this study, when the participants felt anxiety, they may have tried to move to the next question without full confidence, which is an escape behavior. In this case, the increase in cognitive load caused by anxiety may have been underestimated in the eye tracking data, because fixation time, which was used to measure confidence, was shorter than it was supposed to be.

H5 proposed that cognitive load would moderate the distraction effect on task performance. Previous research supported the existence of this moderation effect because distraction is created by working memory resource distribution (Schaap et al., 2018). Moreover, mandatory distraction creates extraneous load while multitasking creates intrinsic cognitive load (Trafton et al., 2003). However, the data does not support this hypothesis. One plausible explanation is that the participants had limited motivation to complete the primary task. The participants may have decided to invest a certain amount of energy in the assigned task based on their motivation. When the cognitive load increased, the participants may have decided to pick the most likely answer after a certain amount of time. In that case, the influence of cognitive load may have been mitigated. In addition, because the primary task was a multiple-choice question, the participants could pick an answer without full confidence in their answer. The accuracy rate might not, then, accurately reflect their understanding and the effort spent on the primary task.

The main analysis found that the cognitive load is not significantly moderate the distraction effect on task performance, but a post hoc analysis shows that cognitive load does mediated the distraction effect on task performance by increasing task time. As suggested by previous research (Aldholay et al., 2018; Jr, Hult, Ringle, & Sarstedt, 2016; Preacher & Hayes, 2004, 2008), we conducted a bootstrapping analysis (5000 samples, N=217) to test the mediation effect of cognitive load on the path distraction to time spend on task. The result shows that the indirect distraction effect on time spend on task through cognitive load was significant (p=.005). The indirect effects is 4.754, with 0 outside of the 95% confidence intervals (LL = 1.445, UL = 8.522) (see Figure I1 in appendix a). Following suggestion made by Baron and Kenny's (1986), we found a direct significant path between distraction and cognitive load increase (β=.248, P=.006), a direct significant path between cognitive load and time spend increase (β=.736, P<.001), an indirect significant path between distraction and time spend increase through cognitive load (β=.183, p=.006), and a direct significant path between distraction and time spend increase (β=.141, P=.018) (see Figure I2 in appendix a). This means that cognitive load partially mediates the relationship between distraction and the time spent on task.

H6 hypothesized that the multitasking individuals would be less anxious than individuals who experienced mandatory interruptions. Previous research has suggested that mandatory interruption may cause a heighted feeling of stress and anxiety, because it generates the feeling that less time is available (Jett & George, 2003). Multitasking is less likely to cause anxiety because the participant would still be in the state of flow (Csikszentmihalyi, 1990). The data shows that the distraction group and the multitasking group did suffering from different levels of anxiety. However, the multitasking group suffered from more anxiety. A plausible explanation is that the multitasking group spent significantly more time on the secondary task than did the mandatory distraction group. As a result, the multitasking group experienced more anxiety, which supports the idea that a feeling of having less time available causes higher anxiety.

H7 proposed that multitasking individuals would have a lower level of cognitive load than individuals in the mandatory interruption group. The multitasking individual prefers to shift attention at a low cognitive load point (Janssen et al., 2012; Salvucci & Bogunovich, 2010), while individuals who are mandatorily interrupted have no control over when to shift attention. Hence, the mandatory interruption group should perceive a lower level of cognitive load. However, the data does not support this hypothesis. A plausible explanation is that the multitasking group spent more time on the secondary task and suffered more anxiety than did the mandatory interruption group. According to attentional control theory, anxiety increases cognitive load (Eysenck et al., 2007). Hence, even if the multitasking group did choose a low cognitive point to shift their attention, the amount of cognitive load increase is not less than that of the mandatory interruption group.

H8 predicted that multitasking individuals would perform better than those in the mandatory interruption group. Previous research has shown that the switching cost is higher in a mandatory distraction situation than in a multitasking situation, when the secondary tasks are the same (Janssen et al., 2012). However, in this study the data do not support this hypothesis. One plausible reason is that the effort spent on secondary task mediated the influence of the switching cost difference between these two groups. According to the memory goal theory (Hodgetts et al., 2015), the longer the secondary task takes and/or the bigger cognitive load the secondary task creates, the greater the distraction effect will be. The secondary tasks are different in interruption group and multitasking group. The paper-based message, which is with secondary task, need to be read by the multitasking group is much longer than the pop-up message need to be read by distraction group. Hence, the effort spend on the secondary task is different in interruption group and multitasking. The difference in the effort spend on secondary tasks may explained that the multitasking group in this study did not display better performance than the mandatory interruption group.

This chapter presented the findings of the main study. Eye movement data were collected using the iMotions system and used to complete the data analysis with SPSS 24. The results of this analysis indicate that three out of eight hypotheses were supported. The results were interpreted in detail.

Table 4.2 Hypotheses test result

Hypotheses	Support?
H1: Distracted individuals will exhibit lower primary task performance than individuals who are not distracted.	Yes
H2: Distracted individuals perceive higher levels of anxiety than individuals who are not distracted.	Yes
H3: Distracted individuals perceive higher levels of cognitive load than individuals who are not distracted.	Yes
H4: Anxiety will moderate the influence of distraction.	No
H5: Cognitive load will moderate the distraction effect on task performance.	No
H6: Multitasking individuals experience less anxiety than individuals who experience mandatory interruptions.	No
H7: Multitasking individuals perceive a higher level of cognitive load than individuals who experience mandatory interruptions.	No
H8: Multitasking individuals perform better than individuals who experience mandatory interruptions.	No

CHAPTER V

CONCLUSIONS, IMPLICATIONS AND LIMITATIONS

The objective of this study was to explore the influence of distraction on individual cognition and task performance. To this end, the research involved a review of the literature, hypothesis development, pretesting, pilot testing, and carrying out the main research.

5.1 Implications for research

This study contributes to information systems (IS) scholarship in a number of ways. First, it explored the influence of distraction on individual task performance by integrating distraction-conflict theory (R. S. Baron, 1986), processing efficiency theory (Eysenck & Calvo, 1992), attentional control theory (Eysenck & Derakshan, 2011; Eysenck et al., 2007), cognitive load theory (Paas et al., 2003), and the memory for goals model (Trafton et al., 2003). These perspectives were consolidated specifically to explain the manner by which distraction affects the completion of primary tasks. Second, this study used a physiological tool instead of perception in measuring cognition and task performance—an orientation that is minimally adopted in IS research. The present work addressed this void by using an eye tracking system from iMotions, which proved to be a subjective measurement rather than an objective one. The system was employed to measure an individual's behavior, including the time he/she spends on a task, the cognitive load imposed on him/her, and the anxiety that he/she experiences during task completion. One of the difficulties of examining one-time distractions is that their measurement should be considerably accurate to detect small-scale effects. In this study, the difference between the performance levels of individuals is only a few seconds, thereby rendering an eye tracking system suitable for precisely recording individual behaviors. The iMotions system adopted in this work measures the time at which tasks are performed in milliseconds.

Distractions come in different forms, as examined in previous research, but most of these initiatives inquired into only one type of disturbance. This brings us to the third contribution of the current study—clearing the way for a new way to scrutinize the issue at hand by comparing different types of distractions, namely, mandatory interruptions and multitasking intrusions. The results revealed that the effects of distractions can vary on the basis of a given distraction's characteristics. Fourth, this dissertation investigated the effects of one-time distractions on task performance. Although numerous studies have been devoted to the consequences of distraction in terms of frequency and timing, research on one-time distractions is very limited. The current study filled this gap by focusing on this type of intrusion and its ramifications. Finally, this work adds to existing bodies of knowledge by expanding the framework regarding distraction to encompass the context of human–computer interaction. It probed into the influence of technology-based mandatory interruptions on the performance of tasks and found that computer-induced interruptions delay task completion not only by compelling people to spend time on a secondary task but also by reducing individual efficiency.

5.2 Implications for practice

This research also presents practical implications, such as uncovering empirical evidence that distractions negatively influence individual task performance. We found that an individual's performance diminishes with a brief one-time interruption or a short secondary disruption. From a managerial perspective, this finding indicates that companies should endeavor to reduce interruptions to daily work, create an environment that enables employees to focus on a single task, and refrain from assigning them secondary responsibilities. This study likewise discovered that the increased amount of time spent on a distraction originates not only from time devoted to a secondary task but also from the effects of such task on the cognitive processes of employees. The increased time dedicated to completing a primary task can be longer than an interruption itself, reflecting that in a work environment, the occurrence of frequent, short interruptions severely reduces employee productivity. Form a managerial standpoint, this means that the unfavorable effects of distractions can be mitigated by evaluating productivity during the completion of a secondary task against the reduction in such productivity caused by the distraction's (i.e., the secondary task) effects on primary responsibilities. Simply comparing the benefit–cost rates of secondary and primary tasks is not a valid method of ascertaining whether multitasking is a worthwhile activity. Lastly, this work discovered that distractions increase both anxiety and cognitive load. Anxiety, which is a negative emotion, may reduce the productivity of employees. Emotion management is thus an important component of an organization's overall management scheme, especially when employees are heavily engaged in multitasking. A manager can implement measures for regulating employees' emotional reactions to alleviate the undesirable effects of distractions.

5.3 Limitations and future research

Inevitably, there are limitations in this research. The first is the fact that the sample size limited the methodological options adopted in the analysis. An issue related to this deficiency is the eye tracking process. Eye tracking is a promising technology, but the data collection involved in such systems is very time-consuming. A single data collection session considerably slowed down the speed with which information was derived. Especially in distraction research, only one dataset can be collected at one time, thus also contributing to the problem of generating a relatively small sample size. The scarcity of samples, in turn, constrained the extent of the modeling. We encourage the replication of our study with a larger sample size.

Another limitation is that the eye gazing data would have provided more information when combined with other types of data. Fixation can reflect attention and cognitive load, but it cannot tell us whether an increase in this behavior is caused by intrinsic cognitive load or an emotional reaction. Future research should combine eye tracking data with brain activity data to obtain additional insight.

The last limitation is the decision to forgo an analysis of all the factors associated with secondary task performance. To regulate the scope of the research, focus was directed toward primary tasks; as regards secondary duties, only the time spent on such responsibilities was considered in the analysis. Delving into secondary tasks may cast light on different forms of distractions. According to the memory for goals model, factors such as the cognitive load and goal activity level associated with secondary tasks may influence the effects of distractions. Incorporating more factors related to secondary responsibilities into examinations can enhance our understanding of how these tasks affect disruptions. Future research should control for or provide accurate measures of secondary tasks to potentially create a complete model.

5.4 Conclusion

This research improved our comprehension of the influence of distractions on task performance. To answer the research question: How do task-irrelevant distractions interrupt the users of information systems and influence their performance? this research use eye tracking systems monitored individual's behavior under undistracted condition, mandatory interruption condition and multitasking condition, and then compared their behavior. The data shows that task-irrelevant distraction negatively influenced the users by increase anxiety and cognitive load as well as reduce the overall efficiency with which primary tasks are completed. The total time devoted to primary and secondary responsibilities are prolonged when secondary tasks disrupt the performance of primary tasks. We also found that the influence of distractions does not depend solely on distraction type but also on the characteristics of secondary tasks. This study successfully implemented eye tracking in data collection and analysis, which is a promising method of acquiring behavioral data for distraction research.

REFERENCES

Addas, S., & Pinsonneault, A. (2015). The many faces of information technology interruptions: a taxonomy and preliminary investigation of their performance effects. *Information Systems Journal*, *25*(3), 231–273. https://doi.org/10.1111/isj.12064

Addas, S., & Pinsonneault, A. (2018). E-Mail Interruptions and Individual Performance: Is There a Silver Lining? *MIS Quarterly*, *42*(2), 381–405. https://doi.org/10.25300/MISQ/2018/13157

Adler, R. F., & Benbunan-Fich, R. (2013). Self-interruptions in discretionary multitasking. *Computers in Human Behavior*, *29*(4), 1441–1449.

Adler, R. F., & Benbunan-Fich, R. (2015). The effects of task difficulty and multitasking on performance. *Interacting with Computers*, *27*(4), 430–439.

Alavi, M., & Leidner, D. E. (2001). Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly*, 107–136.

Aldholay, A. H., Isaac, O., Abdullah, Z., & Ramayah, T. (2018). The role of transformational leadership as a mediating variable in DeLone and McLean information system success model: The context of online learning usage in Yemen. *Telematics and Informatics*, *35*(5), 1421–1437. https://doi.org/10.1016/j.tele.2018.03.012

Altmann, E. M., & Trafton, J. G. (2007). Timecourse of recovery from task interruption: Data and a model. *Psychonomic Bulletin & Review*, *14*(6), 1079–1084.

Altmann, E. M., & Trafton, J. G. (2015). Brief Lags in Interrupted Sequential Performance: Evaluating a Model and Model Evaluation Method. *International Journal of Human-Computer Studies*, *79*, 51–65. https://doi.org/10.1016/j.ijhcs.2014.12.007

Alvarez, I., Alnizami, H., Dunbar, J., Jackson, F., & Gilbert, J. E. (2015). Help on the road: Effects of vehicle manual consultation in driving performance across modalities. *International Journal of Human-Computer Studies*, *73*, 19–29. https://doi.org/10.1016/j.ijhcs.2014.07.001

Alzahabi, R., & Becker, M. W. (2013). The association between media multitasking, task-switching, and dual-task performance. *Journal of Experimental Psychology: Human Perception and Performance*, *39*(5), 1485–1496.

Anderson, B. A. (2013). A value-driven mechanism of attentional selection. *Journal of Vision*, *13*(3), 7–7.

Andrés, P., Parmentier, F. B., & Escera, C. (2006). The effect of age on involuntary capture of attention by irrelevant sounds: a test of the frontal hypothesis of aging. *Neuropsychologia*, *44*(12), 2564–2568.

Baddeley, A., Logie, R., Bressi, S., Sala, S. D., & Spinnler, H. (1986). Dementia and working memory. *The Quarterly Journal of Experimental Psychology Section A*, *38*(4), 603–618. https://doi.org/10.1080/14640748608401616

Bailey, B. P., & Iqbal, S. T. (2008). Understanding changes in mental workload during execution of goal-directed tasks and its application for interruption management. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *14*(4), 21–28.

Bailey, B. P., & Konstan, J. A. (2006). On the need for attention-aware systems: Measuring effects of interruption on task performance, error rate, and affective state. *Computers in Human Behavior*, *22*(4), 685–708.

Bailey, B. P., Konstan, J. A., & Carlis, J. V. (2001). The Effects of Interruptions on Task Performance, Annoyance, and Anxiety in the User Interface. In *Interact* (Vol. 1, pp. 593–601).

Baron, R. M., & Kenny, D. A. (1986). The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173–1182.

Baron, R. S. (1986). Distraction-conflict theory: Progress and problems. In *Advances in experimental social psychology* (Vol. 19, pp. 1–40). Elsevier.

Baumgartner, S. E., Weeda, W. D., van der Heijden, L. L., & Huizinga, M. (2014). The relationship between media multitasking and executive function in early adolescents. *The Journal of Early Adolescence*, *34*(8), 1120–1144.

Behroozi, M., Lui, A., Moore, I., Ford, D., & Parnin, C. (2018). Dazed: measuring the cognitive load of solving technical interview problems at the whiteboard. In *Proceedings of the 40th International Conference on Software Engineering New Ideas and Emerging Results - ICSE-NIER '18* (pp. 93–96). Gothenburg, Sweden: ACM Press. https://doi.org/10.1145/3183399.3183415

Bera, P. (2016). How Colors in Business Dashboards Affect Users' Decision Making. *Communications of the ACM*, *59*(4), 50–57. https://doi.org/10.1145/2818993

Bravo, E. R., Santana, M., & Rodon, J. (2016). Automating and informating: roles to examine technology's impact on performance. *Behaviour & Information Technology*, *35*(7), 586–604.

Brooks, S., Longstreet, P., & Califf, C. (2017). Social media induced technostress and its impact on Internet addiction: A distraction-conflict theory perspective. *AIS Transactions on Human-Computer Interaction*, *9*(2), 99–122.

Calvo, M. G. (1996). Phonological working memory and reading in test anxiety. *Memory*, *4*(3), 289–306.

Coraggio, L. (1990). Deleterious effects of intermittent interruptions on the task performance of knowledge workers: A laboratory investigation.

Courage, M. L., Bakhtiar, A., Fitzpatrick, C., Kenny, S., & Brandeau, K. (2015). Growing up multitasking: The costs and benefits for cognitive development. *Developmental Review*, *35*, 5–41.

Covey, S. R. (1989). *The 7 habits of highly effective people: Powerful lessons in personal change* (Vol. 247). New York: Simon & Schuster.

Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience*. Now York.

DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research*, *3*(1), 60–95.

Delone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: a ten-year update. *Journal of Management Information Systems*, *19*(4), 9–30.

Dennis, A. R., & Kinney, S. T. (1998). Testing media richness theory in the new media: The effects of cues, feedback, and task equivocality. *Information Systems Research*, *9*(3), 256–274.

Drews, F. A., & Musters, A. (2015). Individual differences in interrupted task performance: One size does not fit all. *International Journal of Human-Computer Studies*, *79*, 97–105. https://doi.org/10.1016/j.ijhcs.2015.01.003

Durso, F. T., Nickerson, R. S., Dumais, S. T., Lewandowsky, S., & Perfect, T. J. (2007). *Handbook of applied cognition*. Wiley Online Library.

Eisma, M. C., Boelen, P. A., Schut, H. A. W., & Stroebe, M. S. (2017). Does worry affect adjustment to bereavement? A longitudinal investigation. *Anxiety, Stress, & Coping*, *30*(3), 243–252. https://doi.org/10.1080/10615806.2016.1229464

Eysenck, M. W. (1985). Anxiety and cognitive-task performance. *Personality and Individual Differences*, *6*(5), 579–586.

Eysenck, M. W., & Byrne, A. (1992). Anxiety and susceptibility to distraction. *Personality and Individual Differences*, *13*(7), 793–798.

Eysenck, M. W., & Calvo, M. G. (1992). Anxiety and performance: The processing efficiency theory. *Cognition & Emotion*, *6*(6), 409–434.

Eysenck, M. W., & Derakshan, N. (2011). New perspectives in attentional control theory. *Personality and Individual Differences*, *50*(7), 955–960.

Eysenck, M. W., Derakshan, N., Santos, R., & Calvo, M. G. (2007). Anxiety and cognitive performance: attentional control theory. *Emotion*, *7*(2), 336–353.

Farnsworth, B. (2018). Eye Tracking: The Complete Pocket Guide. Retrieved from Retrieved from https://imotions.com/blog/eye-tracking/

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G* Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149–1160.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191.

Fox, A. B., Rosen, J., & Crawford, M. (2009). Distractions, distractions: does instant messaging affect college students' performance on a concurrent reading comprehension task? *CyberPsychology & Behavior*, *12*(1), 51–53.

Gefen, D., & Riedl, R. (2017). Adding background music as new stimuli of interest to information systems research. *European Journal of Information Systems*, *27*(1), 46–61.

Goodhue, D. L., & Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly*, 213–236.

Gould, J. D. (1973). Eye movements during visual search and memory search. *Journal of Experimental Psychology*, *98*(1), 184–195. https://doi.org/10.1037/h0034280

Graydon, J., & Eysenck, M. W. (1989). Distraction and cognitive performance. *European Journal of Cognitive Psychology*, *1*(2), 161–179. https://doi.org/10.1080/09541448908403078

Gross, J. J., Carstensen, L. L., Pasupathi, M., Tsai, J., Götestam Skorpen, C., & Hsu, A. Y. C. (1997). Emotion and aging: Experience, expression, and control. *Psychology and Aging*, *12*(4), 590–599. https://doi.org/10.1037/0882-7974.12.4.590

Gupta, N., & Irwin, J. D. (2016). In-class distractions: The role of Facebook and the primary learning task. *Computers in Human Behavior*, *55*, 1165–1178.

Gupta, P. B., Burns, D. J., & Boyd, H. (2016). Texting While Driving: An Empirical Investigation of Students' Attitudes and Behaviors. *Information Systems Management*, *33*(1), 88–101. https://doi.org/10.1080/10580530.2016.1117884

Hadlington, L., & Murphy, K. (2018). Is Media Multitasking Good for Cybersecurity? Exploring the Relationship Between Media Multitasking and Everyday Cognitive Failures on Self-Reported Risky Cybersecurity Behaviors. *Cyberpsychology, Behavior, and Social Networking*, *21*(3), 168–172.

Hartikainen, K. M., Siiskonen, A. R., & Ogawa, K. H. (2012). Threat interferes with response inhibition. *Neuroreport*, *23*(7), 447–450.

Hodgetts, H. M., Tremblay, S., Vallières, B. R., & Vachon, F. (2015). Decision support and vulnerability to interruption in a dynamic multitasking environment. *International Journal of Human-Computer Studies*, *79*, 106–117. https://doi.org/10.1016/j.ijhcs.2015.01.009

Hopko, D. R., Ashcraft, M. H., Gute, J., Ruggiero, K. J., & Lewis, C. (1998). Mathematics anxiety and working memory: Support for the existence of a deficient inhibition mechanism. *Journal of Anxiety Disorders*, *12*(4), 343–355.

Janssen, C. P., Brumby, D. P., & Garnett, R. (2012). Natural break points: The influence of priorities and cognitive and motor cues on dual-task interleaving. *Journal of Cognitive Engineering and Decision Making*, *6*(1), 5–29.

Jenkins, J. L., Anderson, B. B., Vance, A., Kirwan, C. B., & Eargle, D. (2016). More Harm Than Good? How Messages That Interrupt Can Make Us Vulnerable. *Information Systems Research*, *27*(4), 880–896. https://doi.org/10.1287/isre.2016.0644

Jeong, S.-H., & Hwang, Y. (2012). Does multitasking increase or decrease persuasion? Effects of multitasking on comprehension and counterarguing. *Journal of Communication*, *62*(4), 571–587.

Jett, Q. R., & George, J. M. (2003). Work interrupted: A closer look at the role of interruptions in organizational life. *Academy of Management Review*, *28*(3), 494–507.

Joseph, S. (2013). *Measuring cognitive load: A comparison of self-report and physiological methods*. Arizona State University Tempe, AZ.

Jr, J. F. H., Hult, G. T. M., Ringle, C., & Sarstedt, M. (2016). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. SAGE Publications.

Kahneman, D. (1973). *Attention and effort* (Vol. 1063). Prentice-Hall Englewood Cliffs, NJ.

Kalsbeek, J. W. H. (1964). On the measurement of deterioration in performance caused by distraction stress. *Ergonomics*, *7*(2), 187–195.

Katidioti, I., Borst, J. P., & Taatgen, N. A. (2014). What happens when we switch tasks: Pupil dilation in multitasking. *Journal of Experimental Psychology: Applied*, *20*(4), 380–396.

Kelly, A., Morris, H., Rowlinson, M., & Harvey, C. (2009). The Association of business schools academic journal quality guide. *London: Association of Business Schools*.

Kemker, B. E., Stierwalt, J. A., LaPointe, L. L., & Heald, G. R. (2009). Effects of a cell phone conversation on cognitive processing performances. *Journal of the American Academy of Audiology*, *20*(9), 582–588.

Koch, I., Poljac, E., Müller, H., & Kiesel, A. (2018). Cognitive structure, flexibility, and plasticity in human multitasking—An integrative review of dual-task and task-switching research. *Psychological Bulletin*, *144*(6), 557–583.

Krejtz, K., Duchowski, A. T., Niedzielska, A., Biele, C., & Krejtz, I. (2018). Eye tracking cognitive load using pupil diameter and microsaccades with fixed gaze. *PLoS ONE*, *13*(9), 1–23. https://doi.org/10.1371/journal.pone.0203629

Kurth, S., Majerus, S., Bastin, C., Collette, F., Jaspar, M., Bahri, M. A., & Salmon, E. (2016). Effects of aging on task-and stimulus-related cerebral attention networks. *Neurobiology of Aging*, *44*, 85–95.

Lange, K., Williams, L. M., Young, A. W., Bullmore, E. T., Brammer, M. J., Williams, S. C., … Phillips, M. L. (2003). Task instructions modulate neural responses to fearful facial expressions. *Biological Psychiatry*, *53*(3), 226–232.

Lavie, N., Hirst, A., de Fockert, J. W., & Viding, E. (2004). Load Theory of Selective Attention and Cognitive Control. *Journal of Experimental Psychology: General*, *133*(3), 339–354. https://doi.org/10.1037/0096-3445.133.3.339

Magen, H. (2017). The relations between executive functions, media multitasking and polychronicity. *Computers in Human Behavior*, *67*, 1–9.

Marandi, R. Z., Madeleine, P., Omland, Ø., Vuillerme, N., & Samani, A. (2018). Reliability of Oculometrics During a Mentally Demanding Task in Young and Old Adults. *IEEE Access*, *6*, 17500–17517. https://doi.org/10.1109/ACCESS.2018.2819211

Mason, R. O. (1978). Measuring information output: A communication systems approach. *Information & Management*, *1*(4), 219–234.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review*, *63*(2), 81–97.

Miller, J. G. (1960). Information input overload and psychopathology. *American Journal of Psychiatry*, *116*(8), 695–704.

Milord, J. T., & Perry, R. P. (1977). A methodological study of overloadx. *The Journal of General Psychology*, *97*(1), 131–137.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100.

Monk, C. A., Trafton, J. G., & Boehm-Davis, D. A. (2008). The effect of interruption duration and demand on resuming suspended goals. *Journal of Experimental Psychology: Applied*, *14*(4), 299–313.

Moqbel, M., & Kock, N. (2018). Unveiling the dark side of social networking sites: Personal and work-related consequences of social networking site addiction. *Information & Management*, *55*(1), 109–119.

Moqbel, M., Nevo, S., & Kock, N. (2013). Organizational members’ use of social networking sites and job performance: An exploratory study. *Information Technology & People*, *26*(3), 240–264. https://doi.org/10.1108/ITP-10-2012-0110

Nguyen, L., Barton, S. M., & Nguyen, L. T. (2015). iPads in higher education—Hype and hope. *British Journal of Educational Technology*, *46*(1), 190–203.

Norman, D. A., & Bobrow, D. G. (1975). On data-limited and resource-limited processes. *Cognitive Psychology*, *7*(1), 44–64.

Ophir, E., Nass, C., & Wagner, A. D. (2009). Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences*, *106*(37), 15583–15587.

Paas, F. G., & Van Merriënboer, J. J. (1994). Instructional control of cognitive load in the training of complex cognitive tasks. *Educational Psychology Review*, *6*(4), 351–371.

Paas, F., Tuovinen, J. E., Tabbers, H., & Van Gerven, P. W. (2003). Cognitive load measurement as a means to advance cognitive load theory. *Educational Psychologist*, *38*(1), 63–71.

Paul, C. L., Komlodi, A., & Lutters, W. (2015). Interruptive notifications in support of task management. *International Journal of Human-Computer Studies*, *79*, 20–34.

Pessoa, L., Kastner, S., & Ungerleider, L. G. (2002). Attentional control of the processing of neutral and emotional stimuli. *Cognitive Brain Research*, *15*(1), 31–45.

Petter, S., & McLean, E. R. (2009). A meta-analytic assessment of the DeLone and McLean IS success model: An examination of IS success at the individual level. *Information & Management*, *46*(3), 159–166.

Power, M., & Dalgleish, T. (1997). Cognition and emotion. *From Order to Disorder*.

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers*, *36*(4), 717–731. https://doi.org/10.3758/BF03206553

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, *40*(3), 879–891. https://doi.org/10.3758/BRM.40.3.879

Przybylski, A. K., Murayama, K., DeHaan, C. R., & Gladwell, V. (2013). Motivational, emotional, and behavioral correlates of fear of missing out. *Computers in Human Behavior*, *29*(4), 1841–1848. https://doi.org/10.1016/j.chb.2013.02.014

Ralph, B. C., Thomson, D. R., Cheyne, J. A., & Smilek, D. (2014). Media multitasking and failures of attention in everyday life. *Psychological Research*, *78*(5), 661–669.

Ralph, B. C., Thomson, D. R., Seli, P., Carriere, J. S., & Smilek, D. (2015). Media multitasking and behavioral measures of sustained attention. *Attention, Perception, & Psychophysics*, *77*(2), 390–401.

Rambe, P., & Bere, A. (2013). Using mobile instant messaging to leverage learner participation and transform pedagogy at a South African University of Technology. *British Journal of Educational Technology*, *44*(4), 544–561. https://doi.org/10.1111/bjet.12057

Rogers, R. D., & Monsell, S. (1995). Costs of a predictible switch between simple cognitive tasks. *Journal of Experimental Psychology: General*, *124*(2), 207.

Salvucci, D. D., & Bogunovich, P. (2010). Multitasking and monotasking: the effects of mental workload on deferred task interruptions. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 85–88). ACM.

Salvucci, D. D., & Taatgen, N. A. (2008). Threaded cognition: An integrated theory of concurrent multitasking. *Psychological Review*, *115*(1), 101–192.

Sanderson, P. M., & Grundgeiger, T. (2015). How do interruptions affect clinician performance in healthcare? Negotiating fidelity, control, and potential generalizability in the search for answers. *International Journal of Human-Computer Studies*, *79*, 85–96. https://doi.org/10.1016/j.ijhcs.2014.11.003

Schaap, G., Kleemans, M., & Van Cauwenberge, A. (2018). Second screening for news: Effects of presentation on information processing and program liking. *Computers in Human Behavior*, *84*, 76–85.

Schmidt, L. J., Belopolsky, A. V., & Theeuwes, J. (2015). Attentional capture by signals of threat. *Cognition and Emotion*, *29*(4), 687–694.

Scott, K. M., Nerminathan, A., Alexander, S., Phelps, M., & Harrison, A. (2017). Using mobile devices for learning in clinical settings: A mixed-methods study of medical student, physician and patient perspectives. *British Journal of Educational Technology*, *48*(1), 176–190. https://doi.org/10.1111/bjet.12352

Seddon, P. B. (1997). A respecification and extension of the DeLone and McLean model of IS success. *Information Systems Research*, *8*(3), 240–253.

Sege, C. T., Bradley, M. M., & Lang, P. J. (2018). Avoidance and escape: Defensive reactivity and trait anxiety. *Behaviour Research and Therapy*, *104*, 62–68. https://doi.org/10.1016/j.brat.2018.03.002

Serrano, C. I., & Karahanna, E. (2016). The Compensatory Interaction Between User Capabiities and Technology Capabilities in Influencing Task Performance: An Empirical Assessment in Telemedicine Consultations. *MIS Quarterly*, *40*(3), 597–621.

Shafer, A. T., Matveychuk, D., Penney, T., O'Hare, A. J., Stokes, J., & Dolcos, F. (2012). Processing of emotional distraction is both automatic and modulated by attention: evidence from an event-related fMRI investigation. *Journal of Cognitive Neuroscience*, *24*(5), 1233–1252.

Siciliano, R. E., Madden, D. J., Tallman, C. W., Boylan, M. A., Kirste, I., Monge, Z. A., … Wang, L. (2017). Task difficulty modulates brain activation in the emotional oddball task. *Brain Research*, *1664*, 74–86.

Speier, C., Valacich, J. S., & Vessey, I. (1999). The influence of task interruption on individual decision making: An information overload perspective. *Decision Sciences*, *30*(2), 337–360.

Spielberger, C. D. (2010). *State-Trait anxiety inventory*. Wiley Online Library.

Srivastava, J. (2013). Media multitasking performance: Role of message relevance and formatting cues in online environments. *Computers in Human Behavior*, *29*(3), 888–895.

Szumowska, E., Pop\lawska-Boruc, A., Kuś, J., Osowiecka, M., & Kramarczyk, J. (2018). When frequent media multitaskers perform worse and when they do not: The role of self-regulation ability and strategy manipulation. *Computers in Human Behavior*, *83*, 184–193.

Tichon, J. G., Wallis, G., Riek, S., & Mavin, T. (2014). Physiological measurement of anxiety to evaluate performance in simulation training. *Cognition, Technology & Work*, *16*(2), 203–210. https://doi.org/10.1007/s10111-013-0257-8

Tossell, C. C., Kortum, P., Shepard, C., Rahmati, A., & Zhong, L. (2015). You can lead a horse to water but you cannot make him learn: Smartphone use in higher education. *British Journal of Educational Technology*, *46*(4), 713–724. https://doi.org/10.1111/bjet.12176

Trafton, J. G., Altmann, E. M., Brock, D. P., & Mintz, F. E. (2003). Preparing to resume an interrupted task: Effects of prospective goal encoding and retrospective rehearsal. *International Journal of Human-Computer Studies*, *58*(5), 583–603.

Vance, A., Jenkins, J. L., Anderson, B. B., Bjornn, D. K., & Kirwan, C. B. (2018). Tuning Out Security Warnings: Alongitudinal Examination Of Habituation Through Fmri, Eye Tracking, And Field Experiments. *MIS Quarterly*, *42*(2), 355–380.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 425–478.

Weng, M., Huber, S., Vilgan, E., Grundgeiger, T., & Sanderson, P. M. (2017). Interruptions, visual cues, and the microstructure of interaction: Four laboratory studies. *International Journal of Human-Computer Studies*, *103*, 77–94. https://doi.org/10.1016/j.ijhcs.2017.02.002

Wickens, C. D. (1991). Processing resources and attention. *Multiple-Task Performance*, *1991*, 3–34.

Zhang, Y., & Rau, P.-L. P. (2016). An exploratory study to measure excessive involvement in multitasking interaction with smart devices. *Cyberpsychology, Behavior, and Social Networking*, *19*(6), 397–403.

Zijlstra, F. R., Roe, R. A., Leonora, A. B., & Krediet, I. (1999). Temporal factors in mental work: Effects of interrupted activities. *Journal of Occupational and Organizational Psychology*, *72*(2), 163–185.

Zuboff, S. (1985). Automate/informate: the two faces of intelligent technology. *Organizational Dynamics*, *14*(2), 5–18.

APPENDIX A

ANALYSIS RESULTS FROM SPSS

A.1 Main test results from SPSS24

Correlations

		Cognitive Load	Anxiety	Time	Accuracy	Distraction
Cognitive Load	Pearson Correlation	1	-.622**	.369**	.055	.246**
	Sig. (2-tailed)		.000	.000	.543	.005
	N	127	127	127	127	127
Anxiety	Pearson Correlation	-.622**	1	.150	-.118	-.064
	Sig. (2-tailed)	.000		.092	.185	.477
	N	127	127	127	127	127
Time	Pearson Correlation	.369**	.150	1	.169	.299**
	Sig. (2-tailed)	.000	.092		.057	.001
	N	127	127	127	127	127
Accuracy	Pearson Correlation	.055	-.118	.169	1	.021
	Sig. (2-tailed)	.543	.185	.057		.811
	N	127	127	127	127	127
Distraction	Pearson Correlation	.246**	-.064	.299**	.021	1
	Sig. (2-tailed)	.005	.477	.001	.811	
	N	127	127	127	127	127

**. Correlation is significant at the 0.01 level (2-tailed).

Figure A.1 Correlation test

```
[DataSet2] R:\dissertation related\main study\Hypothese test\3.1 only used.sav
```

Descriptives

stimulation_wmtas_accuracy

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1.00	43	.7209	.45385	.06921	.5813	.8606	.00	1.00
2.00	41	.7073	.46065	.07194	.5619	.8527	.00	1.00
3.00	43	.7442	.44148	.06733	.6083	.8801	.00	1.00
Total	127	.7244	.44858	.03981	.6456	.8032	.00	1.00

Test of Homogeneity of Variances

stimulation_wmtas_accuracy

Levene Statistic	df1	df2	Sig.
.293	2	124	.747

ANOVA

stimulation_wmtas_accuracy

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.029	2	.015	.072	.931
Within Groups	25.325	124	.204		
Total	25.354	126			

Figure A.2 H1 accuracy test

Descriptives

stimulation_wmtas_time_ms

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1.00	43	38.8022	17.98564	2.74278	33.2670	44.3373	5.27	73.19
2.00	41	51.5357	21.29207	3.32526	44.8151	58.2563	16.09	122.14
3.00	43	53.5163	18.81879	2.86984	47.7248	59.3079	16.17	107.68
Total	127	47.8950	20.32514	1.80356	44.3258	51.4642	5.27	122.14

Test of Homogeneity of Variances

stimulation_wmtas_time_ms

Levene Statistic	df1	df2	Sig.
.319	2	124	.728

ANOVA

stimulation_wmtas_time_ms

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5457.453	2	2728.726	7.262	.001
Within Groups	46594.563	124	375.763		
Total	52052.015	126			

Figure A.3 H1 time test

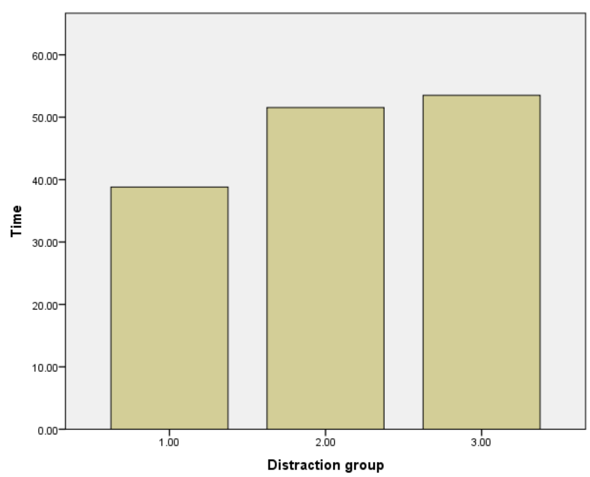

Figure A.3 (continued)

Descriptives

saccadesrate

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1.00	36	37.2222	15.05250	2.50875	32.1292	42.3153	16.00	73.00
2.00	41	49.3659	13.24907	2.06916	45.1839	53.5478	27.00	71.00
3.00	40	39.6220	15.20847	2.40467	34.7581	44.4859	19.10	76.38
Total	117	42.2981	15.32251	1.41657	39.4924	45.1038	16.00	76.38

Test of Homogeneity of Variances

saccadesrate

Levene Statistic	df1	df2	Sig.
.332	2	114	.718

ANOVA

saccadesrate

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3262.063	2	1631.031	7.756	.001
Within Groups	23972.338	114	210.284		
Total	27234.400	116			

Figure A.4 H2 anxiety/saccade rate test

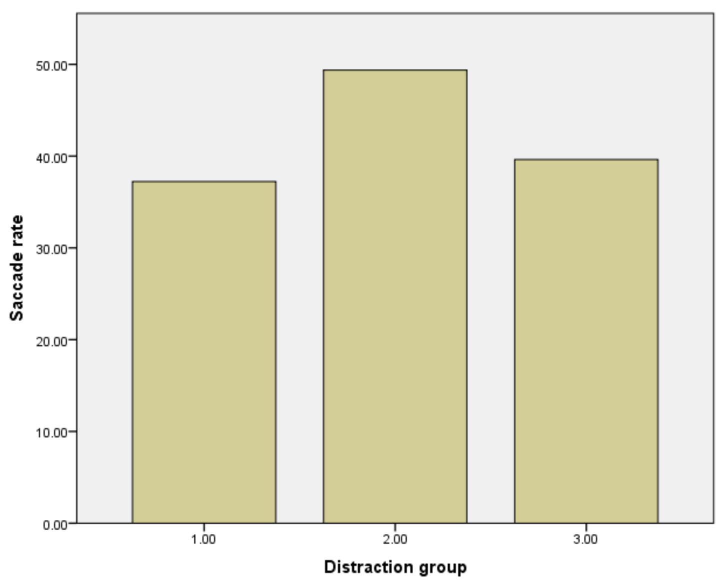

Figure A.4 (continued)

Descriptives

TimespentFms

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1.00	36	24.1366	11.57588	1.92931	20.2199	28.0533	2.37	49.12
2.00	41	29.7034	11.21687	1.75178	26.1629	33.2439	7.16	52.09
3.00	40	31.8567	13.56281	2.14447	27.5191	36.1943	13.13	76.88
Total	117	28.7267	12.48664	1.15439	26.4403	31.0131	2.37	76.88

Test of Homogeneity of Variances

TimespentFms

Levene Statistic	df1	df2	Sig.
.218	2	114	.805

ANOVA

TimespentFms

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1189.473	2	594.736	4.013	.021
Within Groups	16896.799	114	148.218		
Total	18086.272	116			

Figure A.5 H3 Cognitive load/fixation time test

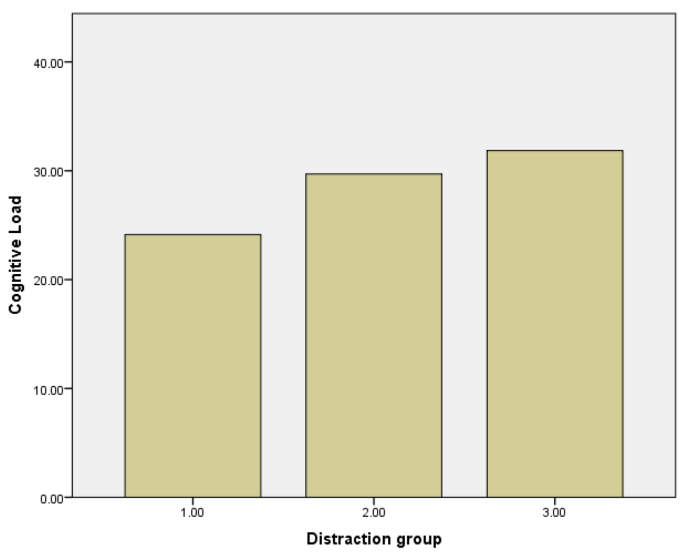

Figure A.5 (continued)

Levene's Test of Equality of Error Variances[a]

Dependent Variable: TimespentFms

F	df1	df2	Sig.
.934	8	108	.492

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + group123 + Axietygroup + group123 * Axietygroup

Tests of Between-Subjects Effects

Dependent Variable: TimespentFms

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5203.460[a]	8	650.433	5.453	.000	.288
Intercept	77477.399	1	77477.399	649.513	.000	.857
group123	2098.974	2	1049.487	8.798	.000	.140
Axietygroup	3648.602	2	1824.301	15.294	.000	.221
group123 * Axietygroup	92.412	4	23.103	.194	.941	.007
Error	12882.812	108	119.285			
Total	114637.403	117				
Corrected Total	18086.272	116				

a. R Squared = .288 (Adjusted R Squared = .235)

Figure A.6 H4 anxiety*distraction moderation test

Levene's Test of Equality of Error Variances[a]

Dependent Variable: stimulation_wmtas_accuracy

F	df1	df2	Sig.
3.232	8	108	.002

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + loadgroup + group123 + loadgroup * group123

Tests of Between-Subjects Effects

Dependent Variable: stimulation_wmtas_accuracy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1.011[a]	8	.126	.614	.764	.044
Intercept	58.799	1	58.799	285.577	.000	.726
loadgroup	.500	2	.250	1.215	.301	.022
group123	.043	2	.021	.104	.901	.002
loadgroup * group123	.522	4	.131	.634	.639	.023
Error	22.237	108	.206			
Total	85.000	117				
Corrected Total	23.248	116				

Figure A.7 Load * distraction on accuracy moderation test

Levene's Test of Equality of Error Variances[a]

Dependent Variable: stimulation_wmtas_time_ms

F	df1	df2	Sig.
1.954	8	108	.059

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + loadgroup + group123 + loadgroup * group123

Tests of Between-Subjects Effects

Dependent Variable: stimulation_wmtas_time_ms

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	23455.558[a]	8	2931.945	13.502	.000	.500
Intercept	244017.769	1	244017.769	1123.695	.000	.912
loadgroup	16050.556	2	8025.278	36.956	.000	.406
group123	3062.119	2	1531.060	7.050	.001	.115
loadgroup * group123	659.436	4	164.859	.759	.554	.027
Error	23452.921	108	217.157			
Total	307976.467	117				
Corrected Total	46908.480	116				

a. R Squared = .500 (Adjusted R Squared = .463)

Figure A.8 Load * distraction on time moderation test

Descriptives

saccades

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
2.00	41	49.3659	13.24907	2.06916	45.1839	53.5478	27.00	71.00
3.00	40	39.6220	15.20847	2.40467	34.7581	44.4859	19.10	76.38
Total	81	44.5541	14.98516	1.66502	41.2406	47.8676	19.10	76.38

Test of Homogeneity of Variances

saccades

Levene Statistic	df1	df2	Sig.
.655	1	79	.421

ANOVA

saccades

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1922.296	1	1922.296	9.466	.003
Within Groups	16042.115	79	203.065		
Total	17964.412	80			

Figure A.9 H6 Distraction vs Multitasking anxiety test

Descriptives

TimespentFms

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
2.00	41	29.7034	11.21687	1.75178	26.1629	33.2439	7.16	52.09
3.00	40	31.8567	13.56281	2.14447	27.5191	36.1943	13.13	76.88
Total	81	30.7668	12.39992	1.37777	28.0249	33.5086	7.16	76.88

Test of Homogeneity of Variances

TimespentFms

Levene Statistic	df1	df2	Sig.
.365	1	79	.547

ANOVA

TimespentFms

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	93.875	1	93.875	.608	.438
Within Groups	12206.766	79	154.516		
Total	12300.642	80			

Robust Tests of Equality of Means

TimespentFms

	Statistic[a]	df1	df2	Sig.
Welch	.605	1	75.595	.439
Brown-Forsythe	.605	1	75.595	.439

a. Asymptotically F distributed.

Figure A.10 H7 Distraction vs Multitasking cognitive loading test

Descriptives

stimulation_wmtas_accuracy

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
2.00	41	.7073	.46065	.07194	.5619	.8527	.00	1.00
3.00	40	.7500	.43853	.06934	.6098	.8902	.00	1.00
Total	81	.7284	.44756	.04973	.6294	.8274	.00	1.00

Test of Homogeneity of Variances

stimulation_wmtas_accuracy

Levene Statistic	df1	df2	Sig.
.731	1	79	.395

ANOVA

stimulation_wmtas_accuracy

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.037	1	.037	.182	.671
Within Groups	15.988	79	.202		
Total	16.025	80			

Figure A.11 Distraction vs Multitasking accuracy test

Descriptives

stimulation_wmtas_time_ms

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
2.00	41	51.5357	21.29207	3.32526	44.8151	58.2563	16.09	122.14
3.00	40	52.6594	18.63082	2.94579	46.7010	58.6178	16.17	107.68
Total	81	52.0906	19.90504	2.21167	47.6893	56.4920	16.09	122.14

Test of Homogeneity of Variances

stimulation_wmtas_time_ms

Levene Statistic	df1	df2	Sig.
.612	1	79	.436

ANOVA

stimulation_wmtas_time_ms

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	25.565	1	25.565	.064	.801
Within Groups	31671.277	79	400.902		
Total	31696.842	80			

Robust Tests of Equality of Means

stimulation_wmtas_time_ms

	Statistic[a]	df1	df2	Sig.
Welch	.064	1	78.090	.801
Brown-Forsythe	.064	1	78.090	.801

a. Asymptotically F distributed.

Figure A.12 Distraction vs Multitasking time test

A.2 Post hoc test results from Amos24

Indirect Effects (Group number 1 - Default model)

Indirect Effects - Lower Bounds (BC) (Group number 1 - Default model)

	group123	TimespentFms
TimespentFms	.000	.000
stimulation_wmtas_time_ms	1.405	.000

Indirect Effects - Upper Bounds (BC) (Group number 1 - Default model)

	group123	TimespentFms
TimespentFms	.000	.000
stimulation_wmtas_time_ms	8.088	.000

Indirect Effects - Two Tailed Significance (BC) (Group number 1 - Default model)

	group123	TimespentFms
TimespentFms	...	...
stimulation_wmtas_time_ms	.005	...

Figure A.13 95 % CI

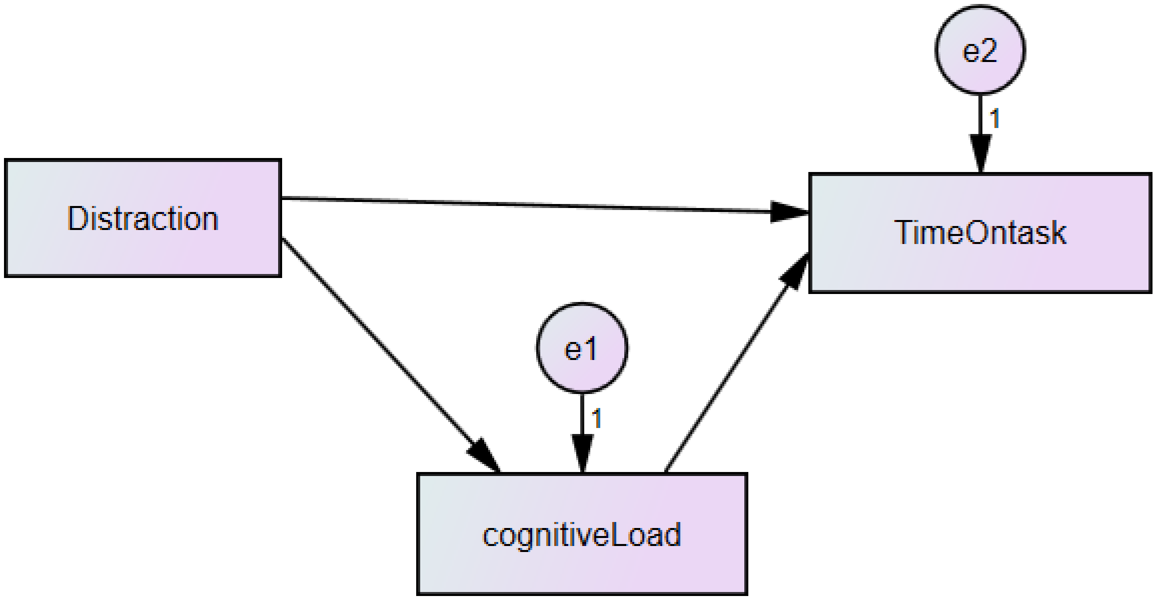

Figure A.14 Mediation model

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
TimespentFms	<---	group123	3.829	1.389	2.757	.006	
stimulation_wmtas_time_ms	<---	TimespentFms	1.186	.096	12.350	***	
stimulation_wmtas_time_ms	<---	group123	3.502	1.482	2.363	.018	

Figure A.15 Mediation test