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INTERRUPTION TYPE AND QUANTITY OF INFORMATION: EFFECTS ON PERFORMANCE AND ATTENTION ALLOCATION

by
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ABSTRACT

OF THE THESIS OF

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Interruptions are an unavoidable part of everyday life that can have a negative impact on behavior and attention. One of the most common types of interruptions are those from cellphones. Cellphone interruptions are especially disruptive during tasks that require continuous attention. While research on cellphone interruptions have confirmed their detrimental effects, little is known about the effects of the type of cellphone interruption, particularly in terms of the nature and amount of data present in the interruption. A large amount of data – also known as clutter or data overload – has been known to lead to performance decrements in a variety of contexts. The goal of this study is to analyze how the nature and amount of data in cellphone interruptions interact to affect performance and attention allocation when studying and recalling information. The first hypothesis was that interruptions of the same nature as the main task are more disruptive. The second hypothesis was that more data will be more detrimental to performance and attention. Attention was tracked by means of an eye tracker. Participants were given material to read and study and were interrupted during that task by a cell phone notification that had either text or image data, and either a low or high amount of data, or not interrupted at all. Each participant experienced all five experimental conditions and was asked to complete a quiz following the study of the material. Results showed that performance was unaffected by the different types of interruptions; however, the eye tracking data provided more insight and showed that participants tended to have more trouble resuming their task after the interruption. The results confirm the detrimental effects of interruptions when learning and recalling information and support the use of better design improvements to help users return to their primary tasks after an interruption.

TABLE OF CONTENTS

ABSTRACT 1
ILLUSTRATIONS 4
TABLES 5
INTRODUCTION AND MOTIVATION 6
BACKGROUND 8
2.1.Interruptions 8
2.2.Factors That Affect Interruptions 9
2.2.1. Interruption Type 10
2.2.2. Amount of Data 11
2.3.Cellphone Interruptions 13
2.4.Eye tracking in Interruption Research 15
THE CURRENT STUDY 19
METHODS 20
4.1.Participants 20
4.2.Experiment Setup 20
4.3.Experiment Stimuli 20
4.4.Experiment Design 24
4.5.Experiment Procedure 26
RESULTS 28
5.1.Performance Results 28
5.2.Eye Tracking Results 29
5.2.1. Number of Fixations 29
5.2.2. Mean Fixation Duration 31
5.2.3. Mean Saccade Length 32
5.3.Subjective metrics 35
5.3.1. Subjective Performance Rating 35
5.3.2. NASA Task Load Index 35
DISCUSSION 37

6.1. H1: Type of Interruption 37
6.2.H2: Amount of Data 39
6.3.Further Findings 40
CONCLUSION AND LIMITATIONS 42
APPENDIX A: FULL LEARNING TEXTS AND ASSOCIATED QUIZZES 44
APPENDIX B: FULL LIST OF INTERRUPTIONS 56
APPENDIX C: NASA TASK LOAD INDEX 65
APPENDIX D: SCREENING INTERVIEW 66
APPENDIX E: PRACTICE LEARNING TEXT AND ASSOCIATED QUIZ 67
APPENDIX F: POST-EXPERIMENT QUESTIONNAIRE 70
REFERENCES 72

ILLUSTRATIONS

Figure

1. A sample of the text interruption content in the low and high data conditions 23

2. A sample of the image interruption content in low and high data conditions 24

3. Number of fixations before and after the interruption 30

4. Median number of fixations after the interruption, across the five conditions 31

5. The change in mean saccade length before and after the interruption at low and high data amounts for text interruptions and image interruptions 33

6. Mean saccade length before and after interruption under the no interruption, image - low data, text - high data, and image - high data conditions 34

TABLES

Table

1: Eye tracking metrics used in this study 25

2: NASA-TLX results and results of the Friedman test..... 35

CHAPTER 1

INTRODUCTION AND MOTIVATION

Frequent interruptions in the workplace can be exhausting, contribute towards lower worker well-being, and act as a work environment stressor (Lin, Zhang & Watson, 2013). Interruptions additionally result in increased stress, annoyance, and anxiety, thereby reducing the quality of task performance and negatively affecting emotional state (Bailey, Konstan & Carlis, 2001). In command and control environments, interruptions have been found to be harmful to long-term performance in terms of speed and accuracy (Loft, Sadler & Braithwaite, 2015). An information worker, such as a software developer or an analyst, typically gets an average of 11 minutes of continuous work before getting interrupted, and needs an average of 25 minutes to resume at the point where the interruption occurred (Mark & Gonzalez, 2004).

The effects of interruptions extend beyond the workplace and can hinder academic performance. In particular, cellphone interruptions have been shown to result in lower performance on an English comprehension task (Froese et al., 2012). The authors concluded that participants who engaged in texting during a simulated classroom lesson scored lower on the subsequent quiz than those who did not text. Interruptions also result in lower academic efficiency: students who messaged during a passage reading task took longer than uninterrupted students to finish the tests that followed for each passage (Fox, Rosen & Crawford, 2009). Interestingly, students expected their cellphone interruptions to negatively affect their performance yet proceeded to switch to the interruption anyway (Fox et al., 2009).

In settings where cellphone usage may not be completely eliminated, it is necessary to evaluate the effects of interruptions on performance and attention. In particular, it is important to explore the effects that different types of interruptions have on retention and attention allocation in order to warn industry workers, students, and parents about the dangers of certain types of interruptions. Hence, the goal of this study is to investigate the extent to which interruptions of varying nature and data levels affect task performance and attention allocation. The application domain is cellphone interruptions, in text and image form, of increasing levels of data. The task chosen for this study is a simple academic task where a student is trying to learn certain material that consists of text and statistics.

CHAPTER 2

BACKGROUND

2.1. Interruptions

An interruption occurs when a flow of work is paused before completion to allow for the completion of another task, provided the users returns to finish the suspended work (Boehm-Davis & Remington, 2009). Interruptions have been identified as the cause of performance decrements and increased worker stress. For example, one study attributed a 4% increase in health problems to interruptions (Lin et al., 2013). Spira and Feintuch (2005) also reported an estimated $588 billion a year in losses due to the impacts of interruptions on productivity, energy, and work satisfaction. Interruptions disrupt task performance (Adamczyk & Bailey, 2004; Altmann, Trafton & Hambrick, 2014; Bailey et al., 2001; Cutrell, Czerwinski & Horvitz, 2001, Trafton & Monk, 2007), as well as situational awareness, which is the perception of elements of the environment with respect to time and space (Endsley, 1995a; Loft et al., 2015), and loss of sequential control (Altmann et al., 2014).

Two main frameworks guide the interruption nature research. The first, Memory for Goals (MfG), suggests that an associative link between the interruption and the main task goal can facilitate resumption (Altmann & Trafton, 2002). The second framework, Multiple Resource Theory, predicts that interruptions of a different nature than the task they are interrupting are more likely to make task resumption easier than interruptions of the same nature (Ratwani, Andrews, Sousk & Trafton, 2008). Nature in this context is defined as the type of cellphone interruption, namely a text notification versus a notification containing an image. Ratwani et al (2008) combined both theories,

and argued that benefits of a different type of interruption are limited to the presence of environmental cues linked to the main task; in a monitoring task for example, where the content to be monitored is displayed on a screen, resumption is faster when interruptions are auditory and visual access to the main task is not blocked.

2.2. Factors that Affect Interruptions

Trafton and Monk (2007) cited several factors possibly impacting interruption disruptiveness, including the length of interruption (resumption lag), rehearsal, environmental cues (in line with the MfG theory), and the nature of the primary task (interruption during more boring, repetitive tasks can speedup performance after resumption). Disruptiveness increases with increasing interruption length. Monk, Trafton, and Boehm-Davis (2008) found resumption to be much faster for short interruption durations. Interruption lag, defined as the time interval between an interruption alert and the interruption itself (Trafton, Altmann, Brock & Mintz, 2003) can also be considered a factor. However, with repetitive practice, users can adapt to disruptions and enhance their resumption speed (Trafton et al., 2003). Moreover, while investigations revealed that performance enhances with increasing task demands, this performance reaches an optimum after which it starts decreasing with increasing demand (Goldberg & Stewart, 1980). Interruptions during a cognitively engaging task are jarring, as resumption is more likely to occur at a different point than that of distraction, hurting sequential flow (Altmann et al., 2014). The timing of interruption is also essential in maintaining performance: Earlier interruptions have a more detrimental

effect than interruptions during a later stage of the task on both performance and memory (Cutrell et al., 2001).

Literature offers conflicting findings in regard to the effects of interruption type and amount of data contained in it. While several studies have linked the similarity between primary task type and interruption type to lower performance (Wickens, Santamaria & Sebok, 2013), Speier, Valacich & Vessey (1999) reported that the negative impact of interruptions on performance is irrespective of their type. Similarly, studies that examined the effect of amount of data involved in interruptions on task performance offer differing results. While some researchers found a decline in performance when interruptions contain more data (Hodgetts & Jones, 2006; Monk et al., 2008), others found no notable difference in performance resulting from increased interruption data amounts (Ziljstra, Roe, Leonora & Krediet, 1999). These differences can be due to the use of different experimental work design parameters, interruption frequencies, task time limits, and primary task nature (Pankok Jr. et al., 2017).

2.2.1. Interruption type

The nature and type of data being presented during a task affects users' performance and their reaction to interruptions (Latorella 1998). Latorella (1998) found that while auditory interruptions are more compelling for response, auditory on-going tasks are more resistant to interruptions, which supports the claim that interruptions of a different type than the main task lead to better performance. This study also concluded that performance errors are highest when the task and interruption are of the same type, which supports the Multiple Resource Theory, although no differences were found

between interruption types in terms of time cost. Similarly, Eyerolle & Cellier (2000) and Lee & Duffy (2012) concluded that similarity between the primary task type and interruption type worsened performance and increased error rate. These studies, conflictingly with Latorella, also found that similarity of task and interruption type resulted in a longer task completion time. Ho, Nikolic, Waters & Sarter (2004) found that participants avoided responding to visual interruptions when the main task is also visual, which can be considered supportive of the Multiple Resource Theory. Later research by Ratwani et al. (2008) found that during interruptions of a different nature than the main task, participants fixated on environmental context relevant to the primary goal. They thus concluded that the advantage provided by interruptions of a different nature is limited to the extent to which environmental cues can be associated with primary task goals. Aurally presented interruptions, for example, facilitate resumption of a visual task to the extent that a user can still associate the suspended primary task goal with an environmental cue.

2.2.2. Amount of Data

Researchers have reached contrasting results when it comes to the effects of the amount of data contained in interruptions. Gillie and Broadbent (1989) found that task completion time when interruptions contain lower amounts of data is shorter than the completion time when they are more packed with data. Eyeroll and Cellier (2000) on the other hand concluded that the amount of data in interruptions did not have an effect on task completion time. Error rate was also found to be higher when interruptions have larger amounts of data (Eyerolle and Cellier, 2000; Monk et al.,

2008). While a higher resumption lag was recorded in several studies for tasks after a more data-dense interruption than after a less data-dense interruption (Monk et al., 2004; Hodgetts and Jones, 2006b; Cades, Werner, Boehm-Davis, Trafton and Monk, 2008), Cades, Davis, Trafton and Monk (2007), however, found this difference to be statistically insignificant. These inconsistencies can be explained through the attention and working memory theory (Couffe and Michael, 2017). Some studies attempt to explain the relationship between amount of data and resumption lag though the inability of maintenance processes to function properly. During an interruption, attention switches back and forth between processing the interruption information and preserving primary task information (Plancher and Barrouillet, 2013). Interruptions containing more data require more information processing, thus hinder the maintenance of primary task-relevant information, which in turn affects the resumption lag (Couffe and Michael, 2017). Pankok Jr. et al. (2017) found that higher amounts of data in interruptions can stimulate a productivity increase in a primary visual-manual assembly task. One possible explanation of this behavior, according to Pankok jr. et al (2017), is that participants feel the need to compensate for the time spent processing more complex interruptions (containing higher amounts of data), which is longer than that spent processing more simple interruptions (containing lower amounts of data).

One type of interruption that has received attention in the recent literature is cellphone interruptions, and these are the focus of this study. Cellphone interruptions have been found to worsen efficiency, making task completion time longer (Fox et al., 2009; Drew, Williams, Aldred, Heilbrun & Minoshima, 2018), and lower error detection, as frequent phone interruptions lower the probability of catching errors during a review or validation process (Thibault et al., 2018).

2.3. Cellphone Interruptions

Cellphone interruptions have been consistently proven to be detrimental to task performance in several fields. Horray and Wickens (2006) examined the impact of cellphone use on driving performance by conducting a meta-analysis of the results of over 50 papers assessing the same subject. Their results indicate that cellphone use during driving incurs a large cost on drivers' performance in terms of response time to road hazards, and thus the speed of their reaction to external risks, while other driving tasks, such as lane keeping, incur smaller costs. The impacts of texting, in particular, on driving have also been summarily examined by a meta-analysis of 28 experimental studies by Caird, Johnston, Willness, Asbridge and Steel (2014). Texting while driving is linked to slower reactions to hazards, more care accidents, and impaired vehicle control, and ultimately linked to compromised driving safety (Card et al., 2014).

In the medical field, cellphone interruptions are distracting and possibly dangerous. According to a survey study conducted by Katz-Sidlow, Ludwig, Miller and Sidlow (2012), cellphone interruptions during attending rounds are distracting and can hinder the transfer of important information between attendings and trainees, or between patients and their doctors. Thibault et al. (2018) studied the effects of interruption by phone calls on the performance of pharmacists in medical order validation. Error detection rate was significantly lower when participants were interrupted by phone, which suggests that phone interruptions lower effectiveness, consume attentional resources and damage task performance. In their study, Thibault et al. (2018) used eye tracking to confirm proper error detection on the validation screen.

In the case of learning/classroom situations, cellphone users correctly expect the interruptions to negatively impact their performance. Particularly, in a learning task, cellphone users' performance is diminished as a result of interruptive notification, even though these users are aware of the performance damage that can be induced by cellphone disruptiveness (Froese et al., 2012). Having a cellphone during lectures and quizzes has been shown to damage performance, as cellphone notifications distraction impairs learning and decreases the availability of attentional resources (Mendoza, Pody, Lee, Kim & McDonough, 2018). Mendoza et al. (2018) analyzed students' quiz performance after watching a video recorded lecture. The distraction of students by sending them text messages during the lecture resulted in difficulty to sustain attention over time and lower quiz performances. The researchers concluded that possessing a cellphone in class and receiving messages result in decreased attention during learning, where the latter becomes a secondary task. Cellphone notifications can diminish performance in attention-demanding tasks as they prompt the user to indulge in thoughts irrelevant to the task at hand, even when the notification remains unanswered (Stothart, Mitchum & Yehnert, 2015). Stothart et al. (2015) examined performance of participants completing a SART (Sustained Attention to Response Task) where they were asked to press a key whenever a number appears on the screen except one number. Participants were interrupted by both text and call, and it was found that the probability of making an error increases when disruptions by calls or text messages occur. Similarly, the probability of achieving a fast response decreases in the case of cellphone notification interruptions, even when cellphone users do not respond to the interruption. This suggests that cellphone interruptions are disruptive to task performance even when unanswered., as these interruptions most likely induce task-irrelevant thoughts. While

cellphone interruptions in the form of instant messaging can be described as a negotiated interruption, where users have the choice of engaging at their ease, the more students respond to instant messaging notification, the poorer their grades are (Fox et al., 2009). Some studies, however, found no correlation between cellphone addiction and poor academic performance, and considered GPA more controlled by other factors such as classroom design, age, smoking, using cellphones for academic purposes (Boumosleh & Jaalouk, 2018).

The effects of interruptions have been researched and assessed using several methods. Subjective surveys, such as questionnaires and interviews, measure participants' behavior in a particular situation or expected performance results. Objective performance measures, such as error rate, test results, and completion time also provide a good indication of the effects of interruptions that is simultaneously more accurate than subjective measures, as it eliminates personal bias participants might have when answering subjective questions. Eye tracking has also been used in interruption research as it indicates the parts of a display screen the participant is looking at, and therefore provides insight on attention allocation during task performance (Moacdieh, Devlin, Jundi and Riggs, 2020). The limitations usually associated with eye tracking, such as the inability to distinguish between covert and visual attention, and restriction to foveal vision, are commonly mitigated by combining eye tracking with another type of measurement.

2.4. Eye Tracking in Interruption Research

Eye tracking is a technique aimed at measuring eye movements to determine where a person is looking (Poole & Ball, 2006). The use of eye tracking is supported by the eye-mind hypothesis, which states that where a person is fixating is the current object of attention (Just & Carpenter, 1976). Eye tracking techniques provide an advantage in interruption research as a non-invasive real-time data measure that reflects the effects of the task, stress, and user-specific factors (such as experience and distractibility) on attention (Poole & Ball, 2006).

Most current eye tracking systems use the corneal refection method to measure the point of regard (POR; Goldberg & Wichansky, 2003). This is typically done by means of an infrared camera mounted on a desktop computer or worn by the person (Poole & Ball, 2006). Eye tracking data is built and compiled by recording several components. PORs are used to identify and calculate fixations, defined as stationary PORs indicating that information is being processed (Poole & Ball, 2006). Quick eye movements between these fixations, called saccades, are also an important measure in eye tracking; no visual processing actually takes place during saccades (Rayner & Pollatsek, 1989). A complete sequence of interconnecting saccades and fixations is a scanpath and offers a visual representation of eye movements to the desired target (Poole & Ball, 2006; Noton & Starck, 1971). Eye movements are selected for analysis based on Areas of Interest (AOIs) that are defined by the researcher over certain parts of the display. Finally, the sum of all fixations within a specific AOI is defined as a gaze (Poole & Ball, 2006).

Interruptions have been studied using eye movements in several fields. Hodgetts, Vachon & Tremblay (2014) used eye tracking metrics to study the impact of interruptions and background noise in a radar operating task, a complex, rapidly evolving setting. Fixations after interruption became shorter than before. This difference in mean fixation duration indicates that participants needed to exert a higher search effort in the primary task after being interrupted. Fixation durations took longer to return to their pre-interruption levels when participants resumed their task in the presence of distracting sounds than in silence. This measure indicates that the attentional resources of participants were divided, and they were putting in more effort to reach the same information when distracted by external sounds, hence their performance and search efficiency were diminished.

Cauchard, Cane & Weger (2011) used eye tracking to analyze the effects of interruptions on reading task performance. Mean fixation time was shorter during uninterrupted trials than during music or speech interruptions, indicating that task completion took longer because of interruptions. However, interruptions led to an increased saccade length and decreased gaze duration, which indicates that although the task completion time was increased by the interruption, comprehension and text procession following the interruption was actually facilitated.

In the medical field, eye movement research revealed that telephone interruptions during diagnostic practices decreased efficiency, but did not affect accuracy (Drew et al., 2018). In this study, examination of dwell time in three areas of interest (medical images, dictation screen, and other location) revealed that radiologists spent less time after interruptions looking at medical images and more time looking at

dictation screens that serve as memory aids, which indicates that they may have forgotten what they observed prior to the interruption.

Additionally, using eye tracking to investigate the effect of interruption nature on performance revealed that aurally presented interruptions allowed for faster and more efficient task resumption than visual interruptions. Much higher frequency of fixations on the current or next task was observed in the auditory interruption-visual task condition than any other condition. Hence, participants in this condition were looking at relevant locations more often than in other conditions, and therefore their resumption will be faster (Ratwani et al., 2008). This conclusion is reinforced by further findings that auditory interruptions during a reading task, particularly music interruptions, only affect the text portion read immediately prior, while the comprehension of the new information is actually facilitated; examining eye tracking data revealed that while both types of interruption resulted in lower fixation times while rereading the pre-interruption text and reading the post-interruption text, fixation time following the music interruption was lower than that following the speech interruption (Cauchard et al., 2011).

CHAPTER 3

THE CURRENT STUDY

While these findings provide insight into the attentional and cognitive consequences of interruptions, further conditions need to be explored, specifically in cellphone interruptions. The current study used eye tracking to examine the effects of the nature of cellphone interruptions on performance and attention allocation during a reading comprehension task.

More specifically, this study tested two hypotheses. The first (H1) is related to the type of cellphone interruption; we expected that text interruptions will lead to worse performance. This was based on evidence that interruptions of the same type as the main task lead to more disruption (Cauchard et al., 2011; Eyerolle and Cellier, 2000; Lee and Duffy, 2012; Ratwani et al., 2008). The second hypothesis (H2) is related to the amount of data in the interruption; we expected that more data will lead to worse performance decrements (Couffe and Michael, 2017; Monk et al., 2008), even for the same amount of time spent on the interruption.

This study adds to the literature on cellphone interruptions impact on task performance for varying interruption types and amounts of data. This study also helps clarify the extent to which attentional resources are affected by cellphones during a reading comprehension task, and provides guidance for more engaging designs of this type of task.

CHAPTER 4

METHODS

4.1. Participants

The participants were 26 undergraduate and graduate students from the American University of Beirut (AUB), aged from 18 to 31 years old, and have normal or corrected to-normal vision. They were recruited via word of mouth. The study procedure was approved by the AUB Institutional Review Board (IRB).

4.2. Experiment Setup

The experiment took place in the Ergonomics Laboratory (Scientific Research Building, Room 407). Participants were seated at around 60 cm from a 27- inch monitor with a resolution of 1680 x 1050 pixels. A Tobii X3-120, desktop mounted and infrared-based eye tracker was located underneath the monitor and used to record the eye movement of the participants at a sampling rate of 120 Hz and accuracy of 0.4 degrees visual angle. The eye tracking data was analyzed and extracted using iMotions software, which is installed on the computer. Participants were supplied with a cellphone to use instead of their own cellphones, which ensured that no external and unplanned notifications interrupted the experiment.

4.3. Experiment Stimuli

The main task was to read a document (a learning text) about one of five different and random subjects, in preparation for a subsequent multiple-choice quiz.

Each of the texts contained between 594 and 609 words. There were four questions per quiz. There was also one practice text (580 words) that was used at the start of the experiment for participants to become familiar with the task.

The five texts to read, in addition to the practice text, are the following:

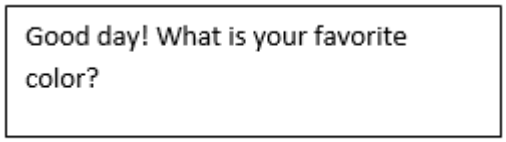
- Life of a Gladiator ("The Life of a Gladiator", 2020).
- The McDonald's coffee lawsuit (Cain, 2007).
- Presidential pets (Leonard, n.d.).
- Seven ways Victorian fashion can kill (StarInsider, 2020).
- Children and TV (Hill, 2016).
- Dance language of the honey bee ("Dance language of the honey bee", 2019).

The full texts and their corresponding quizzes can be seen in Appendix A. They were displayed on the monitor using a full screen PDF display. The font type was Times New Roman and the font size was 12 for all texts.

In addition to the texts, the experiment stimuli consisted of the interruptions themselves. These were divided into two types, the text interruptions and the image interruptions. The text interruptions were sent to the phone given to participants using the WhatsApp application from the experimenter's phone. There were nine different text interruptions developed. Two out of these were used for each participant and one was used in the practice task. For each text interruption, there were two versions developed, one low text version and one high text version (see Figure 1, and see Appendix B for a full list of all the interruptions). Participants never received the same

interruption in two formats. Once they received the interruption, participants had to provide the answer to the question verbally to the experimenter within the time limit.

The image interruptions also consisted of nine different sets of images, each of which is related to a different topic (e.g., driving, food, etc.). For each set, there was one individual image in addition to a combination of 6 images (see Figure 2, and see Appendix B for a full list of the images). The images were sent to participants via WhatsApp as well, and they had to tell the experimenter of which memories these images remind them, within the time limit. As with the text interruptions, Two out of the nine image sets were used for each participant, and one was used for the practice task. Participants never received the same interruption as one image and multiple images. Thus, for each participant, there was one of two possible combinations of interruptions that they could be assigned to.



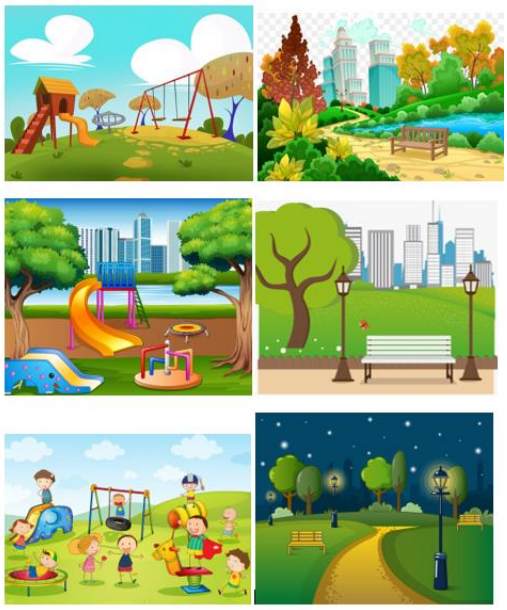
(a)

Hey! I just got back from painting class, and we used so many colors. You would not believe how many colors you can make by simply mixing a few basic ones! The center was very far away though and it was raining. I forgot my umbrella and I was very hungry. They opened a new yoga center near my house, and it looks very good. Anyway, you should join me next time in paint class. what is your favorite color?

(b)

Figure 1: A sample of the text interruption content in: (a) the low data condition, and (b) the high data condition

(a)



(b)

Figure 2: A sample of the image interruption content in: (a) the low data condition, and (b) the high data condition.

4.4. Experiment design

There are two independent variables in this study. The first is the nature of the data in the cellphone interruptions (text, image), and the second is the amount of data in the cellphone interruptions (low data, high data). The design is within-subjects and full factorial, including a control condition. In other words, each participant will experience five conditions: no interruption, text-low data, text-high data, image-low data, and image-high data. The learning texts were counterbalanced using a Latin square, according to which each text was assigned to one of the five experimental conditions for each participant. The order of the experimental conditions and the assignment of interruption sets were also counterbalanced across participants using a Latin square.

The dependent variables consist of performance measures, eye tracking data, and subjective measures. The performance measure is the test score on quizzes, averaged across each condition. The eye tracking metrics that were calculated and the corresponding indications are detailed in Table 1, with the whole learning text considered one AOI. Finally, the subjective measures were collected using a post-experiment debriefing questionnaire and a NASA-Task Load Index (TLX; see Appendix C), which is a subjective assessment tool used to assess the perceived workload of subjects throughout the experiment. The NASA-TLX was modified by removing the physical effort measure, as this experiment does not require any physical effort by the participants. The post-experiment questionnaire (see Appendix D) was used to gather background information about the participants, such as how often they use their phone while studying and how well they think they did on the multiple-choice questions.

Table 1: Eye tracking metrics used in this study.

Eye Tracking Metric	Indication
Number of fixations	A higher number of fixations indicates more distraction and a less efficient search.
Mean fixation duration (seconds)	A longer fixation duration indicates more visual information processing and thus more distraction.
Mean saccade length (pixels)	A higher mean length indicates a lower scan efficiency and more distraction.

4.5. Experiment Procedure

Participants were first asked to sign a consent form and then briefly informed of the general purpose of the study. The experimenter then conducted a short screening interview with each participant to ensure all the necessary experiment inclusion criteria were met (see Appendix D). Participants were then given a brief presentation about what they will have to do. Participants were given a cellphone and were asked to put their own cellphones away to ensure that there were no external interruptions. Participants were instructed to tend to the notification once received.

A practice test (Appendix E) was administered where participants were given five minutes to read the practice text, and then two and a half minutes to complete the subsequent multiple-choice quiz. The practice test featured one text interruption and one image interruption, chosen at random from the interruption sets. Next, the eye tracker was set up and calibrated using a nine-point grid. A set of crosshairs was displayed at the center of the screen in between stimuli, and participants were asked to focus on the crosshairs to ensure a common gaze position at image inception. The actual experiment then started after the practice task, once participants have asked any remaining questions they have.

For each experimental condition, participant were given five minutes to read the corresponding learning text. An interruption occurred during the reading phase for each experimental condition, except during the no interruption condition. The timing of the interruption was varied between one, one-and-a-half, two and two-and-a-half minutes into the main task between conditions. This served to prevent participants from figuring out the time of interruption and expecting it at a specific time in each condition,

which may affect the accuracy of results. This timing was based on previous literature (e.g., Bailey et al., 2001, Cauchard et al., 2001, Mendoza et al., 2018). The interruption itself lasted for 30 seconds, based on an average of what was used in previous literature (Bailey et al., 2001; Cades et al., 2007; Ratwani et al., 2008). This time spent on the interruption was compensated to ensure that every participant had exactly five minutes of reading time. Once the five minutes had passed, a multiple-choice answer quiz consisting of four questions appeared, which the participants had two and a half minutes to complete. After each condition was completed, participants filled out a modified NASA-TLX (Appendix C) to assess the impact of each condition on workload and difficulty. This assessment was not timed. The WhatsApp application was kept open on the cellphone to ensure that participants directly saw the intended interruption format (text or image) rather than the text notification that usually appears when a WhatsApp message is received on a locked phone. Participants were given a one-minute break between conditions. At the completion of the study, participants were asked to fill a post-experiment questionnaire (Appendix F) about their cellphone use and how they believe it is affecting their attention and comprehension, in addition to how much they think the interruption hurt their performance during the experiment. This questionnaire also asked participants to indicate whether they knew any of the quiz answers beforehand and if so, which questions. This took around three minutes. The whole experiment took between 60 to 75 minutes.

CHAPTER 5

RESULTS

Unless stated otherwise, the dependent measures were analyzed using a 2x2x2 repeated measures ANOVA. SPSS was used to detect and remove any significant outliers in the data points. The normality of the data was confirmed using the Shapiro-Wilk test and normal Q-Q plots. In the case where normality was not assured, a non-parametric equivalent test (the Friedman test) was used instead. Bonferroni adjustments were used for all multiple comparisons and partial eta squared (η_p^2) was used as a measure of effect size, and Greenhouse-Geisser approximations were used in cases where the assumption of sphericity was not met according to Mauchly's test. The error bars on all graphs represent the standard error of the mean (*SEM*) and asterisks on the graphs indicate significant differences between conditions.

5.1. Performance Results

For the test scores, a Friedman test was used because the data was not normally distributed. The results showed no statistically significant differences in test scores under the various conditions. The mean test score when no interruption occurred was 75.96% (*SD* = 0.18), while the mean test score was 76.92 % (*SD* = 0.2) under the text interruption - low data condition, 80.77% (*SD* = 0.19) under the image interruption - low data condition, 81.73% (*SD* = 0.18) under the text interruption - high data condition, and 80.77% (*SD* = 0.2) under the image interruption - high data condition.

5.2. Eye Tracking Results

The eye tracking metrics were all calculated in MATLAB. Unless otherwise specified, the data was analyzed using a 2x2x2 three-way repeated measure ANOVA. The normality assumption of the repeated measures ANOVA was satisfied, as evidenced using a Shapiro–Wilk test. The sphericity condition was met as there are only two levels of each independent variable.

5.2.1. Number of Fixations

A 2x2x2 repeated measures ANOVA showed no significant nature*amount interaction effect, nature*time interaction effect, amount*time interaction effect, or nature*amount*time interaction effect. However, there was a significant increase in the number of fixations from 260.21 (*SD* = 14.82) before the interruption to 446.67 (*SD* = 26.65) after the interruption ($F(1,22) = 105.182$, $p = 0.000$, $\eta_p^2 = 0.827$). The test showed no significant simple main effect of the nature of interruption (344.4 (*SD* = 21.7) before the interruption, 362.5 (*SD* = 19.2) after the interruption) or the amount of data in the interruption (351.1 (*SD* = 21.96) before the interruption, 355.77 (*SD* = 18.66) after the interruption).

A paired samples t-test showed a significant increase in the number of fixations after the interruption, compared to the number of fixations before the interruption (see Figure 3). This was the case in all four interruption conditions: text - low data ($t(25) = -4.37$, $p = 0.000$), image - low data ($t(25) = -4.6$, $p = 0.000$), text - high data ($t(25) = -3.5$, $p = 0.002$), and image - high data ($t(22) = -4.42$, $p = 0.000$). The effect size was calculated using Cohen's *d*, the results were as follows: 0.857 for the text interruption -

low data condition, 0.9 for the image interruption - low data condition, 0.682 for the text interruption - high data condition, and 0.921 for the image interruption - high data condition. For the no interruption condition, a Friedman test was used in place of a paired samples t-test, as the data was not normally distributed. It showed that the decrease in median number of fixations in the second half of the dataset under the no interruption condition was significant, $\chi^2(1) = 9.85$, $p = 0.002$.

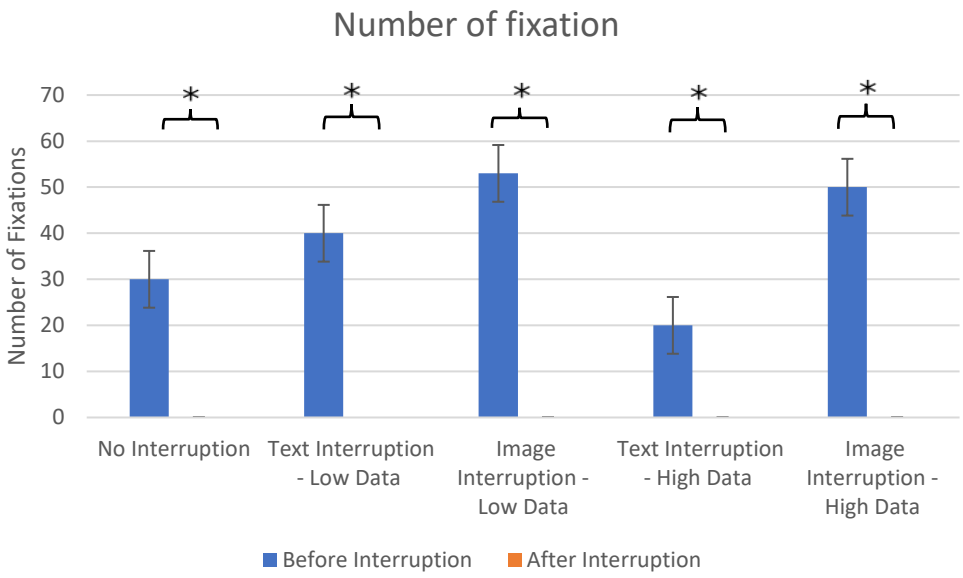


Figure 3: Number of fixations before and after the interruption.

A Friedman test was used in place of a one-way repeated measures ANOVA to compare this metric just after the interruption across all conditions, as the data for number of fixations under the no interruption condition failed the normality test. The results showed a significant difference in the number of fixations between these conditions, $\chi^2(4) = 20.246$, $p = 0.000$ (see Figure 4). The symmetry of differences

assumption was not satisfied, therefore a Sign test was used in place of a Wilcoxon signed-rank test for Post Hoc analysis. There was a significant difference in the median number of fixations between the no interruption condition and the text interruption - low data condition (Z = -3.334, p = 0.001), image interruption - low data condition (Z = -2.942, p = 0.003), text interruption - high data condition (Z = -2.157, p = 0.031), and image interruption - low data condition (Z = -2.942, p = 0.003) (see Figure 4).

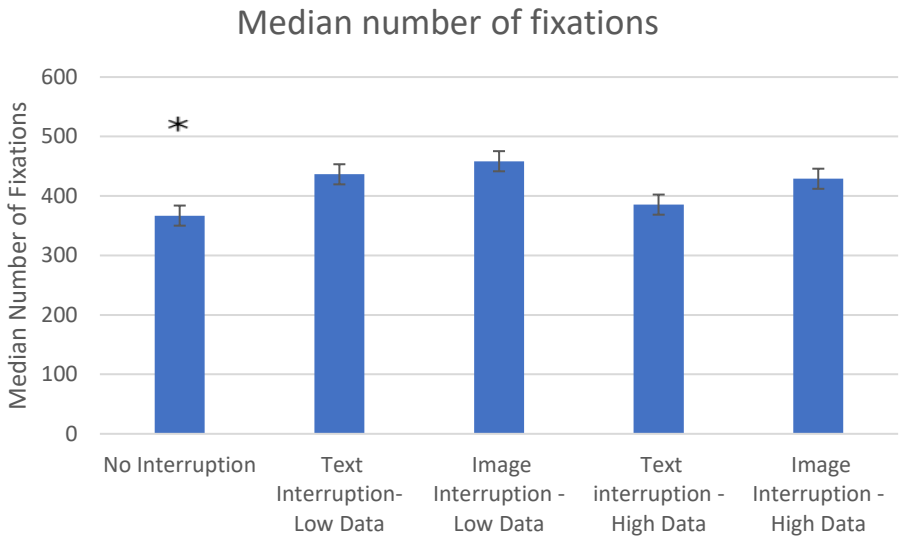


Figure 4: Median number of fixations after the interruption, across the five conditions.

5.2.2. Mean Fixation Duration

A 2x2x2 repeated measures ANOVA showed no significant nature*amount interaction effect, nature*time interaction effect, amount*time interaction effect0, or nature*amount*time interaction effect. There was no significant difference in mean

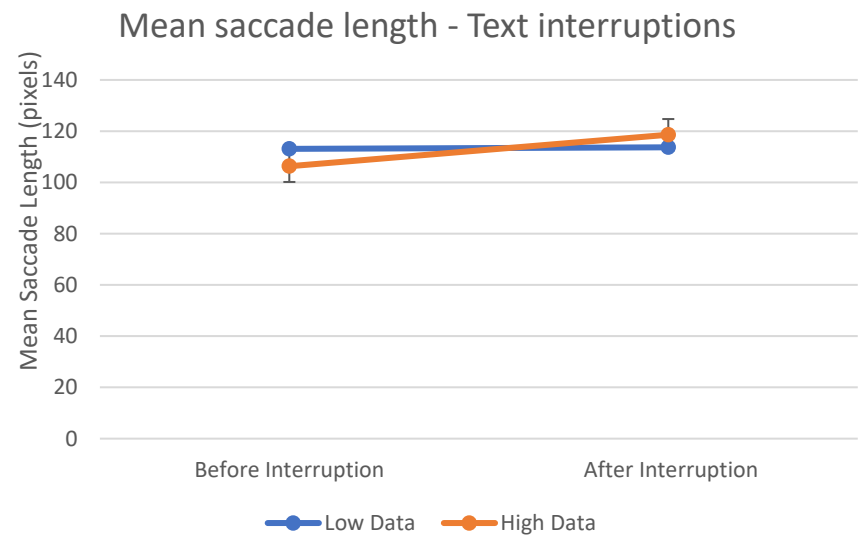
fixation duration before (190.87 msec, *SD* = 6.73) and after the interruption (186.75 msec, *SD* = 5.63). There was also no significant main effect of the nature of interruption or amount of data in the interruption.

A paired samples t-test showed that the change in mean fixation duration before and after the interruption was insignificant under all five conditions: no interruption, from 194.57 msec (*SD* = 6.7) to 189.61 msec (*SD* = 6.1); text - low data condition, from 189.46 msec (*SD* = 8.37) to 189.57 msec (*SD* = 7.38); image - low data, from 190.85 msec (*SD* = 6.79) to 186.46 msec (*SD* = 4.72); text - high data, from 194.29 msec (*SD* = 7.47) to 185.51 msec (SD = 6.92); image - high data, from 194.56 msec (*SD* = 8.31) to 188.01 msec (*SD* = 6.43).

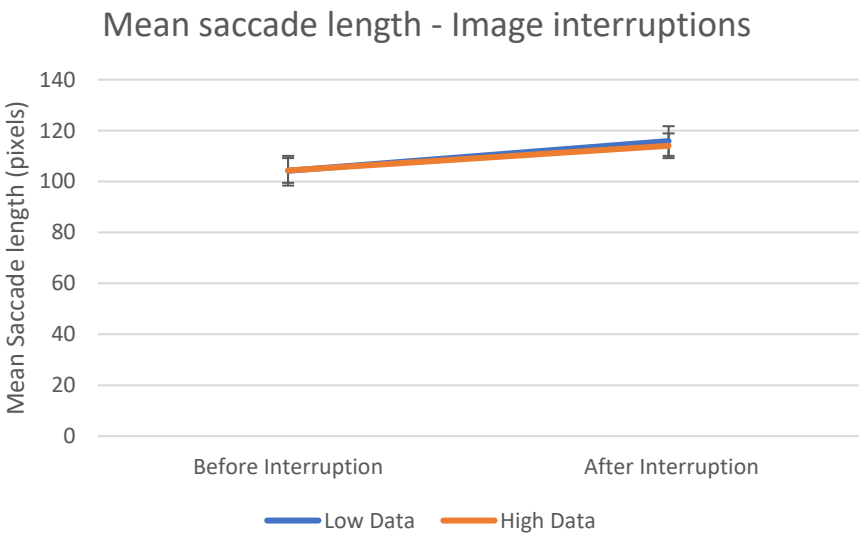
A one-way repeated measures ANOVA determined that there are no significant differences in mean fixation duration values after the interruption between all five conditions.

5.2.3. Mean Saccade Length

A 2x2x2 repeated measures ANOVA showed a significant nature*amount*time interaction effect ($F(1,24) = 4.539$, $p = 0.044$, $\eta_p^2 = 0.159$) (see Figure 5). However, it did not show any significant nature*amount interaction effect, nature*time interaction effect, or amount*time interaction effect. The test also showed a significant increase in mean saccade length from 106.99 pixels (*SD* = 5.73) before the interruption to 115.55 pixels (*SD* = 5.89) after the interruption ($F(1,24) = 14.127$, $p = 0.001$, $\eta_p^2 = 0.371$). There was no significant main effect of the nature of interruption or the amount of data in the interruption.



(a)



(b)

Figure 5: The change in mean saccade length before and after the interruption at low and high data amounts for (a) text interruptions and (b) image interruptions.

A paired samples t-test determined that the increase in mean saccade length after the interruption was significant under the following four conditions: no

interruption condition, $t(23) = -3.78$, $p = 0.001$; image - low data condition, $t(25) = -3.55$, $p = 0.002$; text - high data, $t(25) = -2.37$, $p = 0.026$; image - high data, $t(24) = -2.98$, $p = 0.006$ (see Figure 6). The effect size was calculated using Cohen's d and the results were as follows: 0.775 for the no interruption condition, 0.695 for the image interruption - low data condition, 0.464 for the text interruption - high data condition, and 0.596 for the image interruption - high data condition. The change was insignificant under the text - low data condition, increasing minutely from 113.1 pixels ($SD = 7.52$) before the interruption to 113.7 pixels ($SD = 5.93$) after the interruption.

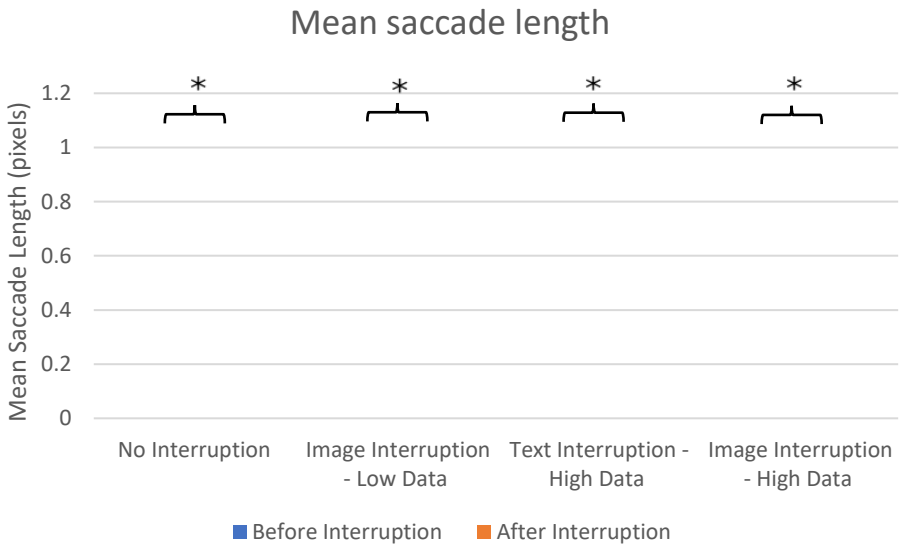


Figure 6: Mean saccade length before and after interruption under the no interruption, image - low data, text - high data, and image - high data conditions.

A one-way repeated measures ANOVA was used to compare the mean saccade length just after the interruption across all conditions. The results were insignificant.

5.3. Subjective Metrics

5.3.1. Subjective Performance Rating

Participants were asked to rate their performance on a scale from 1 to 5 in 3 instances: overall performance, performance under text interruption conditions, and performance under image interruption conditions.

A Friedman test indicated that participants rated their performance in all 3 cases similarly, $\chi^2(2) = 4.817$, $p = 0.09$. The median subjective performance rating was 4 overall (mean = 3.65, *SD* = 0.797), 3.5 under text interruption conditions (mean = 3.15, *SD* = 1.12), and 3.5 under the image interruption condition (mean = 3.23, *SD* = 1.107).

5.3.2. NASA Task Load Index

A Friedman test determined that there was no statistically significant differences in the NASA-TLX metrics across all five conditions (Table 2).

Table 2: NASA-TLX results and results of the Friedman test

NASA-TLX	Median, no interruption	Median, text-low data	Median, image-low data	Median, text-high data	Median, image-high data	Result
Mental Demand	3	4	3	3	4	$X^2(4) = 7.392$, p=0.117

Temporal Demand	2	3	2	2	2	$X^2(4) = 2.651$, $p=0.618$
Performance	3	3	2.5	3	2.5	$X^2(4) = 4.068$, $p=0.397$
Effort	3.5	4	4	3	4	$X^2(4) = 4.995$, $p=0.288$
Frustration	2	2.5	2	2	2	$X^2(4) = 5.763$, $p=0.218$

CHAPTER 6

DISCUSSION

The aim of this study was to analyze the effects of different types of cellphone interruptions on performance and attention allocation, under low and high amounts of data in the interruptions. Low data respectively. The first hypothesis (H1) was that performance and attention will be worsened when the interruption is of the same nature as the main task, compared to when it is of the same nature. The second hypothesis (H2) is that for both types of interruption, more amounts of data will lead to worse performance and attention allocation than low amount of data.

6.1. H1: Type of Interruption

The performance results obtained in this experiment suggest that the type of interruption did not cause any significant differences in test performance or attention allocation. Contrary to our expectations, this suggests that text interruptions are not more detrimental to performance than image interruptions. These results are inconsistent with literature on the effects of interruptions in learning tasks, where cellphone interruptions resulted in worse test performance (Fox et al., 2009; Mendoza et al., 2018), even when unanswered (Stothart et al., 2015). They are also inconsistent with studies that concluded a more detrimental effect on performance when the task and interruption are of the same type (Eyerolle & Cellier, 2000; Lee & Duffy, 2012). However, these results are consistent with other studies, such as Speier et al. (1999), which found that the impact of interruptions on performance is not dependent on their type. In addition, Hodgetts and Jones (2006b) and Hodgetts et al. (2014) both found that

performance error rate is insensitive to interruptions. Hodgetts and Jones (2006b) suggested that the reason for this finding in their study was that the experiment was not too complex. It could be the case that the reading task used in this study was too easy. Other studies that confirmed the detrimental effects of interruptions on performance employed more difficult tasks such as file creation, regularization, and modification tasks (Eyerolle and Cellier, 2000), simulation of threat evaluation and response management (Hodgetts et al., 2014), and submarine track management task (Loft et al., 2015). Hodgetts et al. (2014) reported that the observed increase in completion time may have been the reason for the maintained performance accuracy where participants took their time to reconstruct mental context. It could be the case that the time given to participants in this experiment for reading allowed for enough time to reread the text and preserve accuracy. Cutrell et al. (2001) found that interruptions in earlier stages of the main task are more disruptive to performance and memory than those during later stages. As the time of interruption in this experiment was varied, it is possible that the interruptions' effect on performance was offset because they were not always early on relatively to the main task.

The eye tracking metrics also showed no differences in attention allocation, search efficiency, or processing difficulty between text interruptions and image interruptions. These results are generally inconsistent with literature (Ratwani et al., 2008; Cauchard et al., 2011) which have shown that interruptions of the same nature as the main task make resumption more difficult than interruption of a different nature. These effects on eye movements could have been caused by the fact that participants had to talk aloud while tending to the notification for both types of interruptions, which

may have been disruptive enough to result in similar eye movement patterns across conditions.

6.2. H2: Amount of Data

Performance results indicate that, contrary to our hypothesis, the amount of data contained in an interruption did not affect performance and attention allocation. This outcome is inconsistent with some literature, which showed a connection between the higher amounts of data and worsened performance (Eyerolle & Cellier, 2000; Hodgetts & Jones, 2006; Monk Et al., 2008). However, it is in line with the findings of other studies (Ziljstra et al., 1999). As stated previously, it is possible that the texts were too easy to comprehend, or that participants' interest in the topics enhanced their performance. Additionally, rereading of the pre-interruption portion of the text was allowed, which may have contributed to the lack of effect on performance. As highlighted by Oulasvirta & Saariluoma (2006), lack of accessibility to the pre-interruption text significantly hindered task performance. Further research could investigate performance effects when access to the pre-interruption text is blocked; performance results may change, in line with the Long-Term Working Memory theory (Cauchard et al., 2011).

However, the eye tracking metrics provided an interesting interaction result regarding the amount of data in the text interruptions. Although fixations increased under both low and high data amounts, successive fixations were far apart only under high data amounts, suggesting that participants followed a slower, more efficient search pattern when the text interruption contained low data amounts, and a less efficient,

possibly more chaotic search pattern when it contained high data amounts. This was not the case for image interruptions, as the decrease in search pattern efficiency after the interruption was similar for both low and high data amount. This is somewhat consistent with previous interruption literature, in line with the Working Memory theory, where it was found that increasing amounts of data in the interruption require more information processing, which hinders the preservation of information relevant to the main task (Plancher and Barrouillet, 2013; Couffe and Michael, 2017).

6.3. Further Findings

The eye tracking metrics provided interesting results in terms of the effects of an interruption in general. The number of fixations suggests that the interruption resulted in a less efficient search pattern at resumption. The insignificant change in mean fixation duration indicates that visual processing did not increase after the interruption, implying that participants did not spend longer times looking at the text and subsequently did not have more difficulty processing the information. The increase in mean saccade length, coupled with an increase in the number of fixations, suggests that attention is more far reaching as participants took longer to move between fixations, with successive fixations being far apart. The increase in these two metrics also indicates that participants were skimming through the text after the interruption, scrambling about and trying to recover, possibly to make up for the perceived loss of time caused by the interruption. The disruptiveness and difficulty to return to where participants stopped before the interruption, evident in the eye tracking metrics, did not manifest as performance decrements, which is consistent with the findings of Drew et

al. (2018) where eye movements were significantly affected by interruptions, while performance accuracy was not affected, suggesting effective compensation mechanisms. However, it is possible that with a harder task, or added time pressure for a quick answer, performance results would reflect this disruptiveness.

CHAPTER 7

CONCLUSION AND LIMITATIONS

In summary, these results suggest that although performance and overall time spent looking at the main task is not affected by interruptions, attention becomes less efficient, making recovery from interruption difficult even for an easy reading comprehension task. It appears that after the interruption, participants are skimming through the text, but their scan of the content is less efficient, so they had to reread. Practically, these results provide a warning about the dangers of interruptions when a person is learning or studying, regardless of the nature and type of the interruption. There is a need for better design improvements to help users return to their primary tasks after an interruption.

It is also worth noting that mean fixation duration does not always reflect changes in attention allocation and search efficiency, as evidenced by the findings in this study. This could be due to the fact that mean fixation duration is affected by additional factors such as interest and confusion.

Although the findings of this study are informative, they are not free of limitations. First, generalizing these results is limited to domains with similar task structure, or ones that consist of comprehending reading material with the purpose of recalling it later. Another limitation is that one type of primary task, i.e. visual/text, was studied. Expanding the study to include two or more types of primary task (e.g. auditory, consisting of images, a writing task…) may yield different findings. Additionally, this study is limited to AUB students who represent only a small subset of

cellphone users. This fact, combined with Bonferroni corrections, created a statistical limitation where several mean values narrowly failed to have a significant difference.

APPENDIX A

FULL LEARNING TEXTS AND ASSOCIATED QUIZZES

Text 1:

The Life of a Gladiator

Rather than being a skilled swordsman of high birth, gladiators were armed combatants often forced to entertain the masses in the Roman Republic and Roman Empire. Their violent confrontations took place in the infamous Colosseum, where they faced other gladiators, wild animals and condemned criminals. Irrespective of their origin, gladiators offered spectators an example of Rome‘s martial ethics, and in fighting or dying well, they could inspire admiration and popular acclaim. The significant values a gladiator emboldens can still be seen in gladiators remaining a symbol of Ancient Rome, studied with awe and fascination. The gladiator complex is an interesting one, as despite being the lowest of society and forced to their deaths for others entertainment, they were still celebrated in high and low art, and their value as entertainers commemorated in precious and commonplace objects throughout the Roman world.

Becoming a Gladiator

Majority of the time gladiators were criminals, prisoners of war and most commonly slaves. Being either sold or conquered for the purpose of training them into fierce fighters. But as the games became more and more famed, free men began signing contracts with gladiator schools due to the lure of glory and prize money. Ranging from being desperate men out of work to professional freelance warriors, ex-soldiers, or sometimes even knights. As well, the gender of a gladiator wasn’t always restricted to men. With a rise in female gladiators acclimating by the 1st century to become a common fixture in the games. Usually, these fighters were slaves forced to fight, as women volunteers were scarce. However, the respect of these women was still limited, and their participation was put to an end in 200 A.D. when women fighters were banned.

Their Reputation

Back in the day, instead of Hollywood celebrities, the lower-class citizens of Rome saw gladiators as sex symbols and superstars. Treated similarly to today’s Hollywood stars, these figures had their own endorsements, action figures for children, and public portraits displayed on the streets. Women adored the most successful fighters, dipping their hairpins and jewelry into the fighter’s blood and sweat, sometimes even mixing it with their facial creams. At the peak of gladiator tradition, successful gladiators gained sponsors. These were often political or private citizens who were looking to gain favor with the public, and by sponsoring a gladiator who was in the spotlight, they could hope to gain recognition, as a sort of self-promotion tactic.

The Training of a Gladiator

Due to their being different fights, including full armor, light armor, animal fights, or expert fights, training varied according to the fighter's abilities. Their initial training, however, focused on getting their fitness levels up. They would then introduce weapon training, with wooden swords rather than any high dangerous weapons that could cause the gladiators to die before they got in the area. Moving forward, their training was very much dependent on their build. Light armor fighters practiced their speed, whilst heavy armored fighters who would be slower, required different techniques.

Their Daily Routine

Despite the glory and fame, the life of an average fighter was grime. With most being slaves, they were locked away in their cells at night, only to be woken up at the crack of dawn each morning. As they were seen as high commodities, their hygiene and food were superior to the average citizens, but they were not free to enjoy these extras, with speaking restricted during mealtimes and those not training even shackled. Still, there living conditions were superior to that of the lowest class citizens of Rome.

Quiz:

Free men in Rome were signing contracts with gladiator schools because they were tempted by *

- prize money
- fame
- wars
- high status

Gladiators can be compared to modern day *

- fashion models
- Bollywood stars
- Hollywood stars
- lifeguards

In gladiator weapon training, they used *

- ropes
- animals
- light armor

- wooden swords

Despite being the lowest of society, gladiators were *

- despised and ridiculed
- beaten like other slaves
- celebrated in art
- pushed to their death

Text 2:

The McDonald's coffee lawsuit

At trial, McDonald's argued that Liebeck contributed to her own injuries by placing the coffee cup between her legs and by not removing her clothing promptly after the spill. McDonald's further alleged that the severe nature of the burns suffered by Ms. Liebeck were worse than usual because of her older skin making her more vulnerable to more serious injuries. A McDonald's executive testified that McDonald's had chosen not to warn its customers of the possible severe burns its coffee could cause because "there are more serious dangers in restaurants." McDonald's human factors engineer admitted that the number of hot coffee burns suffered by McDonald's customers are "statistically insignificant" in comparison to the one billion cups of coffee sold by McDonald's each year. The jury deliberated after hearing seven days of evidence, testimony, and arguments of counsel, finding that McDonald's was liable on the claims of product defect, breach of the implied warranty of merchantability, and breach of the implied warranty of fitness for particular purpose. The jury further determined that Ms. Liebeck's injuries merited an award of $200,000 compensatory damages. However, because the jury found that Ms. Liebeck was 20% at fault, that award was reduced proportionately to $160,000. Finally, the jury awarded Ms. Liebeck $2.7 million in punitive damages based on its finding of willful, reckless, malicious, or wanton conduct. The amount of $2.7 million was arrived at based on evidence the jury heard that McDonald's daily coffee revenues amounted to approximately $1.34 million. These exemplary damages represented about two days' worth of McDonald's coffee revenues. However, a fact that rarely ever makes headlines (in this case, or in any allegedly "fraudulent" lawsuit) is that the punitive damages were reduced by the trial court to $480,000 (three times the compensatory damages) for a total award of $640,000. Judge Robert H. Scott, who presided over this trial, stated in regard to the reduced punitive damages award: I think that there was evidence and argument about the Defendant's knowledge that the coffee could cause serious, third degree, full tissue burns. The

Defendant McDonald's knew that the coffee, at the time it was served, was too hot for human consumption…

Judge Scott ordered the parties to engage in a post-verdict settlement conference which resulted in a settlement of the case for an undisclosed amount (less than $600,000) which remains confidential. Ms. Liebeck's case was dismissed with prejudice on November 28, 1994. McDonald's has taken some remedial measures in the aftermath of the Liebeck lawsuit. Many McDonald's drive-thrus now have a sign warning, "Coffee, tea and hot chocolate are VERY HOT!" Also, the lids of McDonald's hot beverage cups are now embossed with the words "HOT! HOT! HOT!" It is debatable whether the coffee at McDonald's is served any cooler than the coffee that injured Ms. Liebeck. Some sources indicate that McDonald's current policy is to serve coffee between 175-195 degrees Fahrenheit. The industry standard still calls for near boiling temperatures for the best-tasting coffee. It appears that the current reaction to coffee lawsuits is to do a better job of warning, but maintain the temperature for better tasting java.

One of the things to learn from this story is that the McDonald's coffee case is not a frivolous lawsuit, as many people believe. In fact, Ms. Liebeck had a very strong case against a very unsympathetic corporate defendant. An argument can obviously be made that the punitive damages should not have been decreased, especially in light of the purpose of punitive damages. A judgment of $480,000 certainly would not be the same deterrent as $2.7 million.

Quiz:

Liebeck contributed to her own injury by *

- placing the cup right next to her
- placing the cup between her legs
- placing the cup near her face
- holding the cup without protecting her hand

Each year, McDonald's sells *

- one billion cups of coffee
- ten million cups of coffee
- ten billion cups of coffee
- one hundred million cups of coffee

The parties were ordered by the judge to engage in *

- public disputes

- verdict negotiations
- compensation mediation
- post-verdict settlement

Lids of McDonald's hot beverage cups are now embossed with *

- VERY HOT!
- HOT!HOT!HOT!
- CAREFUL! HOT!
- CAUTION!HOT!

Text 3:

Presidential pets

Socks:

Perhaps the most famous first feline was Socks. The black and white cat started life as a stray in Arkansas, before catching the attention of Chelsea Clinton and joining the future first family. Shortly after Bill Clinton's election in 1992, Socks became a media focal point, and the family had an issue with photographers luring him out for a photo op. Upon moving to the White House, the Clintons had to keep Socks on a leash while out in the yard. Socks went on to embrace his media presence, becoming the first presidential pet to have a website. He received massive amounts of fan mail, which he always returned with a paw print. In 1997, the Clintons adopted a dog they named Buddy. Socks never warmed to his new canine companion, leading Clinton to quip, "You know, I did better with the Arabs, the Palestinians, and the Israelis than I've done with Socks and Buddy."

Josiah The Badger:

Theodore Roosevelt came into possession of a baby badger on a trip west in 1903. Being Teddy Roosevelt, he named the badger "Josiah," took it home with him, and gave it to his son Archie as a gift. In his autobiography, Roosevelt wrote that his son "used to carry [Josiah] about, clasped firmly around what would have been his waist if he had had any. Inasmuch as when on the ground the badger would play energetic games of tag with the little boy and nip his bare legs, I suggested that it would be uncommonly disagreeable if he took advantage of being held in the little boy's arms to bite his face;

but this suggestion was repelled with scorn as an unworthy assault on the character of Josiah. ‘He bites legs sometimes, but he never bites faces,’ said the little boy.”

Him and Her:

Lyndon Baines Johnson owned a pair of registered beagles, named Him and Her, who became highly visible members of the first family. In 1964, they were also the source of a mini-scandal for LBJ, when he was photographed lifting Him up by his ears. The outcry was so great that Johnson had to issue a public statement regarding the incident, defending the dog’s yelps as “a sound of joy.” Neither dog survived their stay in the White House; Her died in 1964 after swallowing a stone and Him died in 1966 after being hit by an executive chauffeur.

Fowl language of Poll the Parrot:

Andrew Jackson was known as the first president of the people. He was the first president born west of the Appalachian Mountains, the first born in a log cabin, and a frequent participant in duels, once even killing a man. Apparently, his rough nature also extended to his language, as his parrot, Poll, developed a knack for using curse words, presumably learned from Jackson. When the former president died, the bird created such a disturbance at his funeral that it had to be removed.

Pushinka:

Another White House pup with a famous mother was the Kennedy family’s Pushinka, a white mixed-breed whose name means “fluffy” in Russian. Her mother, Strelka, was a Soviet space dog, one of the first two pups to orbit Earth and return safely, aboard Sputnik 2. Soviet Premier Khrushchev sent Pushinka to the Kennedy family, both as a gift and as a bit of bravado, to further rub in the fact that the Soviets were currently winning the Space Race. Kennedy accepted the puppy graciously, writing to Khrushchev that “her flight from the Soviet Union was not as dramatic as the flight of her mother, nevertheless, it was a long voyage and she stood it well.”

Quiz:

Socks caught the attention of *

- Hillary Clinton
- Chelsea Clinton
- Bill Clinton
- Chuck Clinton

"Him" died after *

- swallowing a stone

- Being held up by the ears
- being hit by an executive chauffeur
- being hit by a secret service agent

Pushinka mean fluffy in *

- Serbian
- Russian
- Belarusian
- Chechen

Pushinka's mother was a *

- Soviet army dog
- Soviet space dog
- Soviet family dog
- Soviet guard dog

Text 4:

7 Ways Victorian Fashion Could Kill You

Poisonous dye:

Green was not a very easy color to make. Dressmakers would mix yellow and blue dyes to try and make it. This was until a chemist named Carl Wilhelm Scheele invented a new green pigment. What became known as Scheele's Green, and later Paris Green, was made by mixing potassium and white arsenic in a solution of cooper vitriol. The new green pigment was used for a variety of things, from wallpapers, to candles, toys, and of course fabrics. Arsenic dyes exploded in popularity, but these seemed to cause a few inside effects, including sores, scabs, nausea, colic, diarrhea, and headaches. It's speculated that Napoleon was poisoned due to exposure to arsenic-laced wallpaper he had at home.

Infectious clothes:

Disease would spread through clothes during Victorian times. Soldiers and others would catch disease carried by clothes made or cleaned by sick people. From lice to typhus, fabrics would many times carry diseases and spread them. Poor people would also wear secondhand clothes, and without being properly disinfected, diseases such as smallpox spread through the fabric.

Flowing skirts:

Women's long skirts swept through the dirty city streets, where disease would thrive. These may look glamorous in period dramas, but they didn't really combine well with industrial machinery at the time either. Accidents in factories were reported, and the dresses were banned in some of them as a result. These were also a problem when travelling in carriages and mounting animals.

Flammable fabrics:

Not only were the popular flowy white cotton garments sourced from slave-operated plantations, they were also a real danger for those who wore them: it was more flammable than the heavy silks and wool favored by the wealthy in previous centuries. But it was about to get worse. In 1809, what we know now as tulle was invented. Can it get more flammable than that? Reportedly, in 1845, British ballerina Clara Webster Died after her dress caught fire at a London theater after her skirt came too close to the lights onstage. A popular material for nightshirts and undergarments, the fabric was also susceptible to household accidents, such as catching fire from a candle.

Toxic taxidermy:

Dead birds, such as songbirds, were popular on ladies' hats at the time. The birds as such were not harmful. The arsenic used by taxidermists, however, was. Taxidermists of the day used arsenic-laced soaps and other products to preserve birds and other creatures. Some Victorian fashion commentators decried the practice, though not because of the arsenic involved. One Mrs. Haweis, a writer on dress and beauty, began an 1887 diatribe against "smashed birds" with the sentence: "A corpse is never a really pleasant ornament."

Toxic hats:

If you were an upper-class man in Victorian times, you would have to wear a hat. The problem was that many of those hats were made with mercury. Mercury was used to turn stiff fur from animals such as rabbits and hares into more flexible felt. Mercury would cause a wide range of harmful effects, including convulsions, abdominal cramps, trembling, paralysis, and reproductive problems, among others.

Deadly beauty routines:

Looking extremely pale was definitely in during Victorian times, so why not apply lead white paint to your face? One of the most popular cosmetic products was called Laird's Bloom of Youth. A doctor at the American Medical Association treated three women

who used the product and temporarily lost full use of their hands. He described the condition as “lead palsy”, although today we call it wrist drop or radial nerve palsy, which can be caused by lead poisoning.

Quiz:

The new green pigment was called *

- Scheele's green
- New green
- Wilhelm's green
- Dress green

Clara Webster died because *

- her dress was laced with arsenic
- her dress carried smallpox
- her dress caught fire
- her hat was toxic

Taxidermists used arsenic to *

- turn stiff fur into flexible felt
- disinfect the dead animal
- to preserve the bird
- to make the animal look alive

Because of lead palsy, some women lost *

- total use of their arms
- partial use of their face muscles
- partial use of their arms
- total use of their hands

Text 5:

Children and TV

Parents are often shocked when I tell them that pediatricians think it is a bad idea for children to watch TV or use mobile apps before age 18 months, because most toddlers already have. Surveys tell us that 92.2% of 1-year-olds have already used a mobile device, some starting as young as age 4 months.

Infants may stare at the bright colors and motion on a screen, but their brains are incapable of making sense or meaning out of all those bizarre pictures.

It takes around 18 months for a baby's brain to develop to the point where the symbols on a screen come to represent their equivalents in the real world.

What infants and toddlers need most to learn is interaction with the people around them. That doesn't mean that they shouldn't video-chat with a distant grandparent or a deployed parent, but when it comes to day-to-day learning they need to touch things, shake them, throw them, and most of all to see the faces and hear the voices of those they love the most. Apps can teach toddlers to tap and swipe at a screen, but studies tell us that these skills don't translate into real-world learning.

So sure, babies and toddlers don't get anything out of watching TV, but if they seem to like it, where's the harm? If a little TV is what it takes for you to get dinner on the table, isn't it better for them than, say, starving? Yes, watching TV is better than starving, but it's worse than not watching TV. Good evidence suggests that screen viewing before age 18 months has lasting negative effects on children's language development, reading skills, and short term memory. It also contributes to problems with sleep and attention.

If *"you are what you eat,"* then the brain is what it experiences, and video entertainment is like mental junk food for babies and toddlers.

The problem lies not only with what toddlers are doing while they're watching TV; it's what they aren't doing. Specifically, children are programmed to learn from interacting with other people. The dance of facial expressions, tone of voice, and body language between a toddler and parent is not only beautiful, it's so complex that researchers have to record these interactions on video and slow them down just to see everything that's going on. Whenever one party in this dance, child or parent, is watching TV, the exchange comes to a halt.

A toddler learns a lot more from banging pans on the floor while you cook dinner than he does from watching a screen for the same amount of time, because every now and then the two of you look at each other.

Just having the TV on in the background, even if "no one is watching it," is enough to delay language development. Normally a parent speaks about 940 words per hour when a toddler is around. With the television on, that number falls by 770! Fewer words means less learning.

Toddlers are also learning to pay attention for prolonged periods, and toddlers who watch more TV are more likely to have problems paying attention at age 7. Video programming is constantly changing, constantly interesting, and almost never forces a child to deal with anything more tedious than an infomercial.

After age 2 things change, at least somewhat. During the preschool years some children do learn some skills from educational TV. Well-designed shows can teach kids literacy, math, science, problem-solving, and prosocial behavior. Children get more out of interactive programs like *Dora the Explorer* and *Sesame Street* when they answer the characters' questions.

Quiz:

Most toddlers have already used a mobile device, some as young as *

- 5 months
- 1 year
- 4 months
- 18 months

Viewing screens at less than 18 months old has lasting negative effects on *

- reading skills
- writing skills
- attentional skills
- communication skills

Normally, with no TV on, parents speak around *

- 770 words per hour
- 1000 words per hour
- 850 words per hour

- 940 words per hour

Apps teach children to *

- listen to music
- press buttons constantly
- tap and swipe on a screen
- stare at bright colors

APPENDIX B

FULL LIST OF INTERRUPTIONS

Text Interruptions

Set 1:

Good day! What is your favorite color?

Hey! I just got back from painting class, and we used so many colors. You would not believe how many colors you can make by simply mixing a few basic ones! The center was very far away though and it was raining. I forgot my umbrella and I was very hungry. They opened a new yoga center near my house, and it looks very good. Anyway, you should join me next time in paint class. what is your favorite color?

Set 2:

What is the sum of 9 plus 8?

One of the most interesting mathematicians is John Nash. He fundamentally changed economic calculations, made large contributions to game theory and differential equations. He was schizophrenic. His accomplishments affected decision making in a multitude of applications and shaped modern economic theory. What is the sum of 9 plus 8?

Set 3:

Drinking enough water is one of the most important pillars of maintaining good health. It is usually recommended to drink eight glasses of water per day. However, if you are an athlete, it is highly advised to be constantly drinking water to avoid dehydration. It is also encouraged to drink more water if you are overweight. How often do you drink water in the morning?

How often do you drink water in the morning?

Set 4:

Novels are a popular form of literature. They are normally long and written in prose form. Some novel genres include romance, psychological thrillers, horror fiction, crime, fantasy, science fiction, historical fiction, and inspirational. The Novel "Gone Girl" by Gillian Flynn belongs to the crime mystery genre and has garnered large popularity. Have you ever read the novel "Gone Girl"?

Have you ever read the novel "Gone Girl"?

Set 5:

How many hours of sleep per day do you get?

Sleep recurs naturally. Consciousness is altered, sensory activity is inhibited, muscle activity is reduced, and all voluntary muscles are inhibited during rapid eye movement sleep (REM). Quality sleep is as essential for survival as food and water. It plays an important role in many brain functions such as the consolidation of memory. How many hours of sleep per day do you get?

Set 6:

What is your favorite Hollywood movie?

The most common style in American cinema is the classical Hollywood cinema. The term Hollywood describes a style in filmmaking that was adopted by American filmmakers between 1910s and 1960s. Hollywood has many attractions such as the Hollywood walk of fame and Universal Studios. Citizen Kane is often regarded as one of the best Hollywood movies ever. What is your favorite Hollywood movie?

Set 7:

Using notebooks for class notes is becoming more and more disregarded and replaced by simply taking a quick photo of the class material. It is easier and the pictures can then be uploaded to the cloud so as to never risk losing it. However, some people still enjoy taking thorough notes in class or grabbing a recorder and transcribing the notes later. Do you use your phone's camera to take notes?

Do you use your phone's camera to take notes?

Set 8:

do you usually prefer hot or cold weather?

Many people love winter and hate summer. I like cold weather but winter in Beirut is not really fun. Floods every time it rains, big puddles on the road that ruin your walk, and bad smells everywhere. I prefer to spend winter in the mountains, enjoy the snow, maybe indulge in some winter sports like skiing, and breathe clean air that is free of bad smells. Do you usually prefer hot or cold weather?

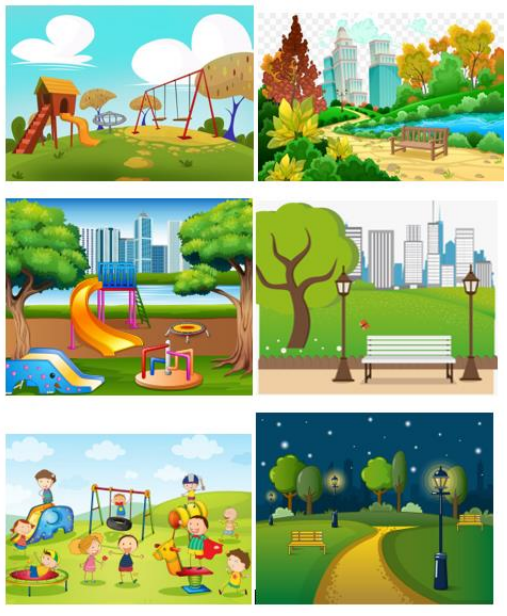
Set 9:

Do you like online classes better than regular classes?

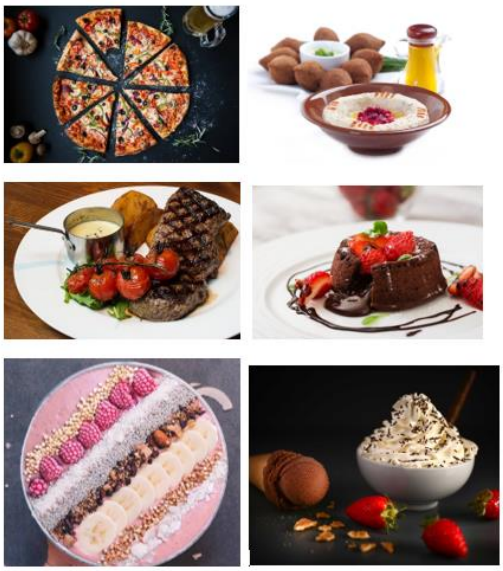
The COVID-19 pandemic has forced a lot of changes into the lives of millions. Working remotely has become the norm, and organizations where technology had almost no role before are adapting to the daily use of advanced technologies, classes have moved online for large portions of the population whether in schools or in universities. Do you like online classes better than regular classes?

Image Interruptions

Set 1:



Set 2:



Set 3:

Set 4:

Set 5:

Set 6:

Set 7:

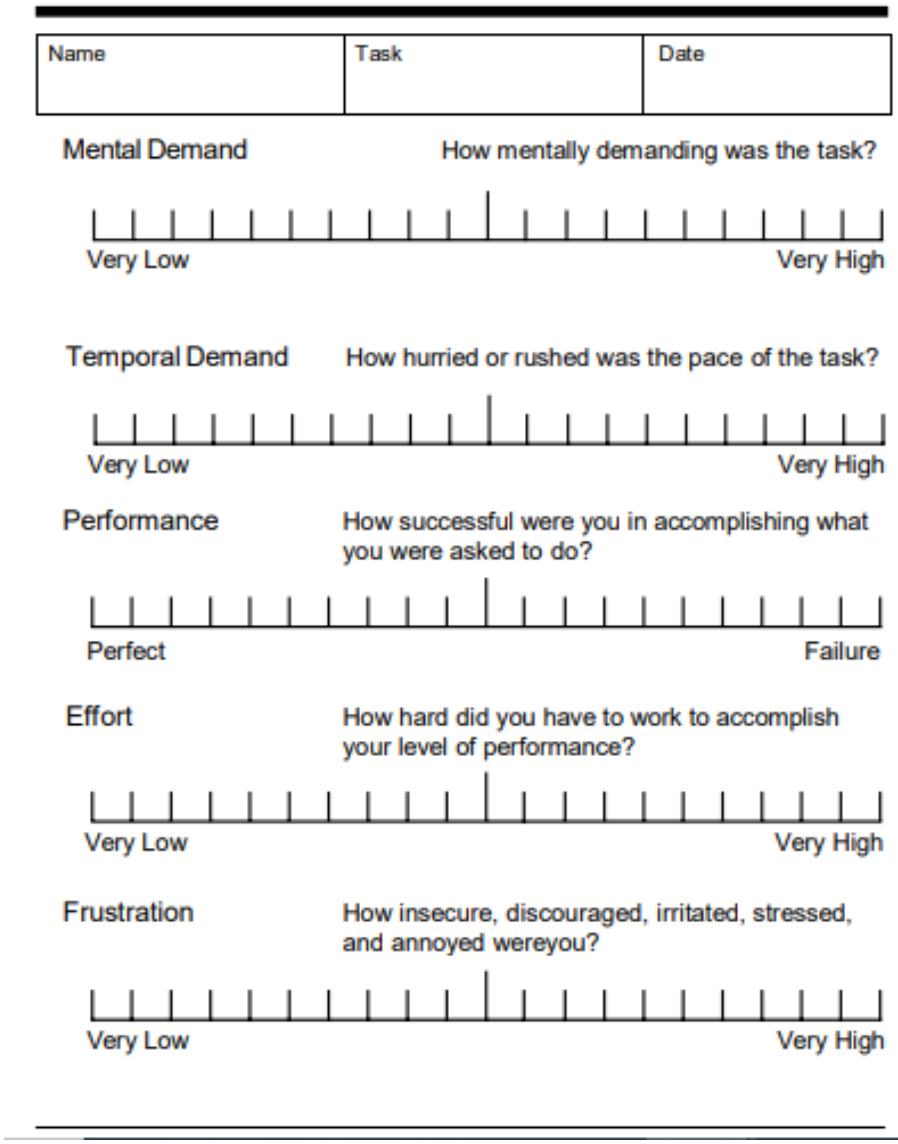
Set 8:

Set 9:

APPENDIX C

NASA TASK LOAD INDEX

Hart and Staveland's NASA Task Load Index (TLX) method assesses workload on five 7-point scales. Increments of high, medium, and low estimates for each point result in 21 gradations on the scales.



APPENDIX D

SCREENING INTERVIEW

1. Do you have any vision problems for which you are not currently using eyeglasses/contact lenses?
2. Do you have perfect color vision?

APPENDIX E

PRACTICE LEARNING TEXT ANDASSOCIATED QUIZ

Text:

Dances of honeybees

Social behavior in bees has a number of advantages. One of the most important of these is the ability to quickly mobilize a large number of foragers to gather floral resources that may only be available for a short period of time. The ability to communicate location with such precision is one of the most interesting behaviors of a very interesting insect.

The recruitment of foragers from a hive begins when a scout bee returns to the hive engorged with nectar from a newly found nectar source. She begins by spending 30-45 seconds regurgitating and distributing nectar to bees waiting in the hive. Once her generosity has garnered an audience, the dancing begins. There are 2 types of bee dances: the round dance and the tail-wagging or waggle dance, with a transitional form known as the sickle dance.

In all cases the quality and quantity of the food source determines the liveliness of the dances. If the nectar source is of excellent quality, nearly all foragers will dance enthusiastically and at length each time they return from foraging. Food sources of lower quality will produce fewer, shorter, and less vigorous dances, recruiting fewer new foragers.

The round dance is used for food sources 25-100 meters away from the hive or closer. After distributing some of her new-found nectar to waiting bees the scout will begin running in a small circle, switching direction every so often. After the dance ends food is again distributed at this or some other place on the comb and the dance may be repeated three or (rarely) more times.

The round dance:

The round dance does not give directional information. Bees elicited into foraging after a round dance fly out of the hive in all directions searching for the food source they know must be there. Odor helps recruited bees find the new flowers in two ways. Bees watching the dance detect fragrance of the flower left on the dancing bee. Additionally, the scout bee leaves odor from its scent gland on the flower that helps guide the recruits.

The waggle dance:

As the food source becomes more distant the round dance is replaced by the waggle dance. There is a gradual transition between the round and waggle dance, taking place through either a figure eight or sickle shaped pattern. The waggle dance includes information about the direction and energy required to fly to the goal. Energy expenditure (or distance) is indicated by the length of time it takes to make one circuit.

For example, a bee may dance 8-9 circuits in 15 seconds for a food source 200 meters away, 4-5 for a food source 1000 meters away, and 3 circuits in 15 seconds for a food source 2000 meters away. Direction of the food source is indicated by the direction the dancer faces during the straight portion of the dance when the bee is waggling. If she waggles while facing straight upward, then the food source may be found in the direction of the sun. If she waggles at an angle 60 degrees to the left of upward the food source may be found 60 degrees to the left of the sun. Similarly, if the dancer waggles 120 degrees to the right of upward, the food source may be found 210 degrees to the right of the sun. The dancer emits sounds during the waggle run that help the recruits determine direction in the darkness of the hive.

Quiz:

The dancing begins after a scout bee disturbs nectar for *

- 20-50 seconds
- 20-35 seconds
- 30-40 seconds
- 30-45 seconds

The liveliness of dances is determined by *

- the closeness of the food source
- the abundance of the food source
- the quality and quantity of the food source
- the color of the food source

Directional information is given through *

- the sickle dance
- the waggle dance
- the tail dance
- the round dance

Energy expenditure is determined by *

- the time it takes to make one circuit
- the time it takes to make one waggle
- the number of waggles made

- the shape made by the dancing bees

APPENDIX F

POST-EXPERIMENT QUESTIONNAIRE

Section 1: general information

How old are you? *

What is your gender? *

- Male
- Female

What year are you at AUB?

- Freshman
- Sophomore
- Junior
- Senior
- Fourth year
- Fifth Year
- Graduate Student
- Other

At what age did you first possess a cellphone?

Were there any quiz answers in this experiment that you already knew? If yes, please indicate which. *

Section 2: Performance and habits

How do you rate your overall performance? *

	1	2	3	4	5	
poor	○	○	○	○	○	excellent

How do you rate your performance when the interruption was a text? *

	1	2	3	4	5	
poor	○	○	○	○	○	excellent

How do you rate your performance when the interruption was an image? *

	1	2	3	4	5	
poor	○	○	○	○	○	excellent

List the following conditions from most distracting to least distracting: no interruption, text interruption-low data (short text), text interruption-high data (long text), image interruption-low data (one image), image interruption-high data (multiple images).

How often do you use your cellphone while attending a lecture at university? *

	1	2	3	4	5	
not at all	○	○	○	○	○	very often

How often do you use your cellphone while attending a lecture online? *

	1	2	3	4	5	
not at all	○	○	○	○	○	very often

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