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Mobile Multitasking While Walking: The Impact of Task Type on Recall Accuracy and the Mediating Effects of Cognitive Absorption

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Comité d'éthique de la recherche

Le 07 décembre 2022

À l'attention de :
Pierre-Majorique Léger
HEC Montréal

Objet : Approbation éthique de votre projet de recherche

 # Projet : 2023-5280

Titre du projet de recherche : The dangers of mobile multitasking : A multimethod approach to examine user distraction, habit, and countermeasure effectiveness.

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Titre de la subvention : The dangers of mobile multitasking : A multimethod approach to examine user distraction, habit, and
countermeasure effectiveness.

Votre projet de recherche a fait l'objet d'une évaluation en matière d'éthique de la recherche avec des êtres humains par le CER de HEC Montréal.

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La présente atteste que le projet de recherche décrit ci-dessous a fait l'objet d'une évaluation en matière d'éthique de la recherche avec des êtres humains et qu'il satisfait aux exigences de notre politique en cette matière.

Projet # : 2023-5280

Titre du projet de recherche : The dangers of mobile multitasking : A multimethod approach to examine user distraction, habit, and countermeasure effectiveness.

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Date d'approbation du projet : 07 décembre 2022

Date d'entrée en vigueur du certificat : 07 décembre 2022

Date d'échéance du certificat : 01 décembre 2023

Maurice Lemelin
Président
CER de HEC Montréal

Signé le 2022-12-07 à 15:13

HEC MONTRÉAL

Comité d'éthique de la recherche

ATTESTATION D'APPROBATION ÉTHIQUE COMPLÉTÉE

La présente atteste que le projet de recherche décrit ci-dessous a fait l'objet des approbations en matière d'éthique de la recherche avec des êtres humains nécessaires selon les exigences de HEC Montréal.

La période de validité du certificat d'approbation éthique émis pour ce projet est maintenant terminée. Si vous devez reprendre contact avec les participants ou reprendre une collecte de données pour ce projet, la certification éthique doit être réactivée préalablement. Vous devez alors prendre contact avec le secrétariat du CER de HEC Montréal.

Nom de l'étudiant(e) : Laurène Del Aguila

Titre du projet supervisé/mémoire/thèse : Mobile Multitasking While Walking: The Impact of Task Type on Recall Accuracy and the Mediating Effects of Cognitive Absorption

Titre du projet sur le certificat : The dangers of mobile multitasking : A multimethod approach to examine user distraction, habit, and countermeasure effectiveness.

Projet # : 2023-5280

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Date d'approbation initiale du projet : 07 décembre 2022

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Signé le 2024-07-23 à 16:04

NAGANO www.nagano.ca Fin de participation d'un étudiant à un projet
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Résumé

Ces dernières années, l'augmentation des accidents chez les piétons met en évidence le phénomène du multitâche en marchant. Ce mémoire explore l'impact de diverses tâches mobiles sur la capacité à se rappeler précisément des éléments environnementaux et du temps, ainsi que du rôle médiateur de l'absorption cognitive.

Une collecte de données a été menée dans un gymnase, impliquant 80 participants, soit 20 participants par type de tâche mobile. Les tâches mobiles examinées incluent les messages textes, la lecture, les jeux vidéo et les vidéos de médias sociaux. Les participants ont marché en utilisant un téléphone mobile et ont complété un questionnaire après la tâche.

Les résultats indiquent que l'absorption cognitive joue un rôle de médiateur partiel dans la relation entre le type de tâche mobile et la précision de rappel de l'environnement et du temps. Les types de tâche mobile influencent directement la capacité des piétons à se rappeler avec des éléments environnementaux. L'utilisation de jeux vidéo en marchant est la tâche la plus difficile pour se rappeler des éléments environnementaux, tandis que les vidéos des médias sociaux ont montré des effets moins prononcés comparé aux de messages textes ou aux jeux vidéo.

Cette étude approfondit nos connaissances sur l'impact de types d'utilisation mobiles sur la capacité des piétons à se rappeler d'éléments environnementaux et leur perception du temps, ainsi que le rôle de l'absorption cognitive. Cette étude vise à contribuer à la prise de décision stratégique pour diminuer ces comportements dangereux liés au multitâche mobile.

Mots clés: texter en marchant - multitâche - absorption cognitive - précision de rappel - type de tâche

Abstract

In recent years, mobile multitasking while walking has gathered significant attention due to a rising number of accidents and fatalities among pedestrians. In response to this growing issue, this study aims to understand to what extent different smartphone task types impact a pedestrian's ability to recall their environment and time, and how cognitive absorption might mediate this relationship.

A data collection was conducted outside the traditional laboratory environment, specifically in a gymnasium. A total of 80 participants were collected, with 20 participants per task type. The mobile task types considered in this study include texting, reading, gaming and watching videos on social media. Participants had to walk around a room using a mobile phone and answer a questionnaire after the task.

Results suggested that cognitive absorption partially mediates the relationship between task type and recall accuracy of environment and time. Additionally, task types directly affect recall accuracy of environment. Gaming emerged as the most challenging task in accurately recalling elements of the environment. Finally, social media videos were shown to affect pedestrians' levels of focused immersion, a sub-dimension of cognitive absorption, though to a lower extent compared to texting and gaming.

This research helps extend our knowledge on how different task types influence pedestrians' recall accuracy of environment and time, as well as the mediating role of cognitive absorption. Our aim is to contribute insights into the effect of mobile multitasking, so that it can aid policymakers and designers into identifying strategies to diminish these dangerous behaviors.

Keywords: texting while walking - multitasking - cognitive absorption - recall accuracy - task type

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CA	Cognitive Absorption
CU	Curiosity
CON	Control
FIM	Focused Immersion
FoMO	Fear of Missing Out
HE	Heightened Enjoyment
MMWW	Mobile Multitasking While Walking
RAE	Recall Accuracy of Environment
RAT	Recall Accuracy of Time
RQ	Research Question
TD	Temporal Dissociation

Preface

This thesis was authorized to be written by the M.Sc. program administration of HEC Montréal. This study was approved by the HEC Montréal Research Ethics Board (CER) in December 2022.

Acknowledgments

I would first like to express my deepest gratitude to my supervisors for their guidance and support throughout this thesis. Ann-Frances Cameron, thank you for your patience and for guiding me through my writing challenges. Pierre-Majorique Léger, thank you for the numerous opportunities you've provided me over the years and for believing in me to finish this thesis.

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Writing this thesis was certainly a challenge, but I am extremely grateful for all the highs and lows I've experienced these few years. They have taught me so much both professionally and personally.

Chapter 1: Introduction

In today's world, handling multiple tasks simultaneously like texting a friend, listening to music, responding to emails has become an integral part of our daily routines raising questions about the impact of multitasking in our daily lives. Multitasking is defined as an individual performing several tasks simultaneously and dividing their attention amongst different tasks (APA, 2006). While multitasking is sometimes praised as being an effective and productive way to carry out tasks (Appelbaum et al., 2008), research today shows quite the contrary. In an academic setting, multitasking has shown to be more distracting for students and affect their academic performance (Carrier et al., 2015; Q. Chen & Yan, 2016). In the workplace, multitasking has been linked to distraction and decreased task performance (Appelbaum et al., 2008). The smartphone has also become a new device in which individuals multitask. Individuals can multitask on their smartphones by simultaneously texting their friends, listening to music, and responding to emails. Multitasking is prevalent in various aspects of our lives but has given rise to behaviors that can potentially be dangerous or even fatal. One such phenomenon that has gained attention in the scientific community is mobile multitasking while walking (MMWW) in which an individual uses their smartphones while simultaneously walking. This behavior puts pedestrians at risk of injury or even death.

To understand why MMWW has become so prevalent today, it is necessary to examine the profound impact smartphones have on users' daily lives. The smartphone has become an essential tool for our daily lives. It has become a tool that we use at work, for fun, to communicate with loved ones, to take pictures and much more. The number of smartphone users worldwide is continuously increasing. Over the years, the number of smartphone users worldwide has continuously expanded from 1,009.94 million in 2014 to 4,883 million in 2024 (Statista, 2024). From 2024 to 2029, this number is forecasted to increase 30.6 percent. A total of 6,377 million users are predicted for 2029 (Statista, 2024). As the number of phone users increases, the number of hours spent on a smartphone has also continuously increased. In 2019, on average Americans spent 225 minutes per day on their phones (eMarketer, 2022). This number has increased to 276 minutes in 2023 (eMarketer, 2022). This number is projected to continuously increase in 2024 for an average of 279 minutes per day (eMarketer, 2022).

Throughout the years, smartphones have transformed from being only a communication tool to multidisciplinary tools where individuals can do various tasks like communicating, playing games, watching videos, listening to music, navigating, etc. With the numerous types of uses available on a smartphone, it has become a tool that can lead to various types of multitasking behaviors. These different types of multitasking behaviors are closely related, but they are relevant in different areas of people's lives and have varying impacts. For example, in the workplace we can notice multitasking behaviors taking place such as Multicommunicating where employees manage multiple conversations simultaneously (Reinsch et al., 2008).

Multicommunicating has been found to potentially have implications in workplace relationships, organizational life, organizational citizenship behavior and workplace satisfaction (Cameron & Webster, 2011). In terms of Media Multitasking, high levels of Media Multitasking have been associated with higher distractibility in young adults (Moisala et al., 2016). Indeed, smartphone users over the years have developed a "checking behavior" in which they repeatedly check their smartphones throughout the day (Oulasvirta et al., 2012). According to a recent survey, the average American check their smartphones 352 times a day (*57+ Incredible Smartphone Addiction Statistics for 2023*, 2022). Some have argued that excessive smartphone use should be classified as a behavioral addiction or as "Smartphone Addiction" (Ting & Chen, 2020). However, this excessive use of smartphones is not currently recognized as a clinical disorder (Ting & Chen, 2020). According to a survey, 47% of Americans have reported being addicted to their phones (*57+ Incredible Smartphone Addiction Statistics for 2023*, 2022).

As smartphone usage and mobile multitasking behaviors continue to rise, they have led to various problematic outcomes, particularly for pedestrians. Over the last decade of 2010 to 2021, there has been a notable 77% increase in pedestrian fatalities, surpassing the lower 25% increase in other traffic-related fatalities (GHSA, 2023). These alarming numbers clearly demonstrate how pedestrian fatalities are increasing faster than other types of traffic fatalities. Various factors can contribute to pedestrian fatalities, such as intoxicated drivers, alcohol impairment in pedestrians, lighting conditions, roadway factors, types of vehicles and urban areas (GHSA, 2023). Another increasingly recognized factor in these incidents is due to technological distractions, such as using smartphones while walking (Thompson et al., 2013). A 2017 report published by the Governors Highway Association (GHSA), mentioned that smartphone use could be a potential and substantial source of distraction for pedestrians. This report also mentioned that in their surveillance database many injuries occurred while pedestrians were engaged in texting activities (Retting & Consulting, 2017).

As mentioned above, pedestrian fatalities have kept increasing until 2021 (GHSA, 2023). The phenomenon of mobile multitasking while walking is present in various areas around the world. In Australia, more specifically the city of Melbourne, a study observed that twenty percent of pedestrians were distracted by smartphones (Osborne et al., 2022). In Korea, accidents with pedestrians using their smartphones increased by 1.9 over a period of four years (Lim et al., 2016). It is quite clear that this smartphone multitasking while walking behavior has not decreased over the past couple of years.

Several strategies have been tested in order to diminish this behavior. Some urban strategies have been implemented such as visual interventions, ground level traffic lights, ground-level warning signals near street crossings (Barin et al., 2018; Kim et al., 2021; Violano et al., 2015). Technological strategies have also been tested such as for example Streebit, a Bluetooth technology that warns pedestrians on their phones when they are crossing the street (Schwebel et al., 2019). Many pedestrian protection systems have been developed with the help of technology: inertial sensors, cameras, acoustic systems, GPS systems, infrared systems, wearable devices, crowd sensing, AR/VR and hybrid systems (Hasan & Hasan, 2022). However, a literature review on existing systems concluded that they aren't adequate for real-world scenarios and further testing needs to be done in order to ensure the safety of pedestrians (Hasan & Hasan, 2022). Overall, these strategies aimed at reducing distracted pedestrians' behaviors have not been widely effective. For future strategies to be developed effectively, additional research is needed to understand the underlying mechanisms of smartphone multitasking and how it can lead to negative consequences for pedestrians.

To deepen comprehension of the underlying mechanisms of smartphone multitasking, an initial exploration of the existing research will provide valuable insight. Existing research has found several effects of smartphone use while walking. A lot of scientific studies conducted on MMW have researched how pedestrian walking behaviors are impacted. Numerous studies have suggested that engaging in smartphone multitasking while walking can influence a pedestrian's gait, resulting in a decrease in walking speed (Agostini et al., 2015; Oh & LaPointe, 2017; Schabrun et al., 2014). Research indicates that pedestrians using their smartphones while walking will exhibit reduced situational awareness and inclined to experiencing inattentional blindness (P. L. Chen & Pai, 2018a; Hyman et al., 2010; Lin & Huang, 2017; Pourchon et al., 2017). An interesting study illustrated this phenomenon, conducted where a unicycling clown would pass by pedestrians, where pedestrians using their phones were less likely to notice a unicycling clown passing on their route compared to those who were not engaged on their phones (Hyman et al., 2010). Numerous studies have shown that pedestrians using their smartphones while walking display riskier and dangerous walking behaviors that could lead to potential accidents and safety concerns (Hossain et al., 2024; Schabrun et al., 2014; Schwebel et al., 2022; Vollrath et al., 2019).

Research has explored the task type on a pedestrian's smartphone as one factor potentially influencing walking behaviors. The majority of studies have predominantly focused on texting (Scopatz & Zhou, 2016; Simmons et al., 2020; Stavrinos et al., 2018) . Although other types of tasks like talking on the phone (Scopatz & Zhou, 2016; Stavrinos et al., 2018; Yadav & Velaga, 2022), reading (Labonte-LeMoyne et al., 2022; Luo et al., 2023; X. Zhang et al., 2023) and listening to music (Dam et al., 2023; Raoniar & Maurya, 2023; Scopatz & Zhou, 2016) have been examined, they haven't received as much attention as texting. Additional studies are needed to gain a more comprehensive understanding of the influence of the type of tasks used on smartphones. A recent study has explored if the type of tasks on your phone influence pedestrian performance. This study investigated the following types of tasks: texting, reading, gaming, group texting and revealed that gaming and texting are associated with diminished walking performance in pedestrians (Labonte-LeMoyne et al., 2022). Additional research is needed to compare various task types between each other to further understand their relative impact on pedestrians. Interestingly, one task type that has received limited attention is the use of social media while walking. In particular the use of short-formed videos on social media applications such as TikTok or Instagram. There is a notable gap in research regarding this task type, in which additional investigation is needed.

Thus, this thesis attempts to answer this first research questions (RQ):

RQ1-During pedestrian multitasking, how does the type of smartphone task influence pedestrians' accuracy of recall?

Many studies have investigated various outcomes related to pedestrian performance. The majority of studies on pedestrian performance while mobile multitasking have focused on gait (Bovonsunthonchai et al., 2020; Ferraro et al., 2022; X. Zhang et al., 2023), walking behaviors and safety (Scopatz & Zhou, 2016; Simmons et al., 2020; Yadav & Velaga, 2022). Other outcomes, such as visual detection (P. L. Chen & Pai, 2018a; Kim et al., 2021; Wang et al., 2022), auditory detection (Davis et al., 2021; Davis & Barton, 2017; Haga et al., 2016), secondary task performance (Chopra et al., 2018; Hinton et al., 2018; Pelicioni et al., 2023) and cognitive processes (Haga et al., 2016; Labonte-LeMoyne et al., 2022; Wang et al., 2022), have also been researched but to a lesser extent. In terms of cognitive processes, no studies have explored the levels of cognitive absorption in pedestrians. Previous research suggested that cognitive absorption could be an interesting outcome to explore but has not yet been tested (Labonte-LeMoyne et al., 2022). There is a notable gap in this area of research, specifically regarding the mediating relationship between various mobile tasks and pedestrian performance (Labonte-LeMoyne et al., 2022). The understanding of the mechanisms involved in how multitasking influences pedestrian performance is limited, particularly regarding cognitive absorption.

This thesis also attempts to answer this second research question:

RQ2-How does cognitive absorption mediate this relationship?

To address these two research questions, a model was built drawing on the existing theories of cognitive absorption, inattentional blindness and time perception. To test the model, a data collection was conducted outside the traditional laboratory environment, specifically in a gymnasium. This experiment used a between-subject design with one factor (type of usage). A total of 80 participants were collected, 20 participants per task type. Participants had to walk around a room using a mobile phone and answer a questionnaire.

This study contributes to the literature by extending our research on the mediating effect of cognitive absorption when pedestrians engage in mobile multitasking activities. It further explores the effect of task types, such as watching short-formed videos, on pedestrians' accuracy of recall. From a practical standpoint, this study’s findings will inform policymakers and designers on strategies to diminish or mitigate this behavior, potentially through techniques that target cognitive absorption to reduce these dangerous behaviors.

In the upcoming section, Chapter 2, the existing body of literature related to mobile multitasking while walking will be explored. In Chapter 3, the development of the research model for this study will be explained. Chapter 4 will consist of explaining the methodology used for the study conducted. In Chapter 5, a detailed description of the analysis and results will be presented. In Chapter 6, the results will be discussed. Finally, Chapter 7 will draw the conclusion of the thesis by summarizing the key contributions, limitations and implications for future studies.

Table 1 presented below outlines the student’s contributions and responsibilities during the research project.

Table 1. Contributions and responsibilities of the student on the research project.

Research Process	**Student Contribution**
Formulation of research questions	Defining the research questions - **60%** ● The student's supervisors had previously worked on this topic and guided them to formulate the research questions. ● By reviewing the literature, the student was also able to aid in the development of the research questions and identify gaps in the literature.
Literature review	Searched scientific databases to find relevant articles and writing of literature review - **100%** ● The student's supervisors gave constructive comments throughout the search and writing process.
Conception of experimental design	Application to the Research Ethics Board (REB) and necessary modifications - **100%** ● Preparation and submission of all necessary forms by the student. ● The student's supervisors and a member of the Tech3Lab team reviewed the forms before submission. Preparation of experiment room - **100%** ● The student was responsible for setting up the experiment room before each participant. ● The student was responsible for the coordination and communication with the gymnasium to have the necessary equipment present in the room. ● The student was also responsible for booking specific time slots with the gymnasium for when the experiment could be conducted. Creation of experiment protocol, stimuli and questionnaires - **100%** ● The student's supervisors gave constructive comments throughout the process.
Participant recruitment	Recruiting participants - **30%** ● The participants were recruited through the institution's panel. ● The student would monitor the panel to ensure participants were registered at each time slot. Development of recruitment form - **100%** Experiment schedule management - **100%** ● The student was responsible for communicating with participants to

	confirm their scheduled time and provide them with the meeting point for the experiment.
Pretests and data collection	Responsible of pretests - **100%** Responsible for data collection - **90%** ● The student was responsible for conducting all the experiments by setting up the room, giving the instructions to the participants, following the experimental protocol and starting all the necessary tools. ● Research assistants would occasionally be present during an experiment. They would sometimes assist the student by meeting participants at the metro and guiding them to the testing room. They also monitored the screen recording to ensure it was functioning correctly. Additionally, research assistants sometimes supported the student in the texting condition by sending messages to participants. Communication and scheduling management with gymnasium - **100%** ● The student would communicate with the gymnasium and schedule specific time slots for participants.
Data extraction and transformation	Extraction and cleaning of the questionnaire data - **100%**
Data analysis	Statistical analysis - **60%** ● The laboratory statistician helped the student choose which statistical tests to use to evaluate the results. ● The student used the SAS software to code the statistical tests. ● The laboratory statistician gave the student constant feedback on how to properly run the tests. ● The student interpreted the results of the statistical analysis. ● The student's supervisors were able to give them constant feedback throughout this process.
Writing	Contribution in writing the thesis - **100%** ● Throughout the process, the student's supervisors gave them constant feedback on their writing.

Chapter 2: Literature Review

This chapter reviews the literature on mobile multitasking while walking and the outcomes of various mobile tasks on pedestrians. It begins with section 2.1 by outlining the objectives, process and structure of the literature review. Section 2.2 examines the outcomes of different task types on pedestrian performance. The following section, section 2.3, reviews studies that have compared mobile task types. Finally, the chapter concludes with a summary of the key findings in section 2.4.

2.1 Objective, Process, and Structure of Literature Review

The objective of this literature review is to investigate scientific studies regarding mobile multitasking while walking, examining the outcomes of various mobile tasks on pedestrians. In the following section, the process of the literature review search will be described by detailing the databases, keywords, and criteria for inclusion and exclusion.

To address the research objectives, extensive research was conducted across several databases such as Web of Science and Google Scholar. The following keywords were used on Web of Science to identify key articles: *mobile, phone, cell, iPhone, pedestrian, walker, multitasking, texting, gaming, music, conversation, browsing, task-switching, impact, effect, consequence, performance,* and *outcomes.* Articles published since 2005 were retrieved. Our decision regarding this date was that the iPhone was released in 2007 (Jones, 2014) and the Blackberry in 2002 (illumy, 2023). A total of 184 articles resulted from this search, including five review papers (Scopatz & Zhou, 2016; Simmons et al., 2020; Stavrinos et al., 2018; Yadav & Velaga, 2022; X. Zhang et al., 2023). Scopatz & Zhou (2016), Stavrinos et al. (2018), Simmons et al. (2020) and Yadav & Velaga (2022) specifically addressed pedestrian walking behaviors and safety, while Zhang et al. (2023) focused on the effects of mobile phone tasks on gait. After reviewing all the articles with specific criterias of inclusion and exclusion, a final selection of 34 articles was included in the review (see Annexe A).

Articles cited and used in the five review articles identified (Scopatz & Zhou, 2016; Simmons et al., 2020; Stavrinos et al., 2018; Yadav & Velaga, 2022; X. Zhang et al., 2023) were excluded to avoid redundancy. For example, Courtemanche et al. (2019) study falls within the scope of this literature review, but it has already been covered by Yadav & Velaga (2022). Additionally, studies that weren't directly related to pedestrian mobile multitasking while walking were excluded. For instance, although Stavrinos et al.'s (2018) systematic review covered mobile multitasking while walking, driving, and cycling, only findings from pedestrian studies were considered. Similarly, studies where participants were not engaged in walking activities were excluded. For example, Wang et al. (2022) presented several experiments and only the walking-related results were considered. Furthermore, tasks not performed on mobile phones were considered out of scope. For instance, in Scoptaz & Zhou's (2016) literature review, several non-phone-related walking activities, including face-to-face conversations with other pedestrians, drinking, eating, and smoking, were excluded from the scope of the study. Only mobile tasks while walking were included (Annexe A).

The structure of the literature review will start with section 2.2, where the various outcomes of task types on pedestrian performance will be examined. Within section 2.2, each paragraph will delve into the literature regarding the following task types: texting, group texting, writing emails, talking on the phone, gaming, browsing, reading, social media, watching videos, and listening to music. In section 2.3, each previously mentioned task type will be examined in terms of its comparisons with other task types. Finally, section 2.4 will summarize the main findings of this literature review and opportunities for future studies.

2.2 The Outcomes of Task Types on Pedestrian Performance

2.2.1 Secondary Task Types and Outcomes Identified in Literature Review

While reviewing the 34 articles, six main outcomes were identified (see the columns of Annexe A). These six outcome categories are as follows: pedestrian walking behavior, gait, visual detection, auditory detection, cognitive processes, and secondary task performance. Furthermore, the types of secondary tasks while walking were examined (see the rows of Annexe A). These secondary task types include texting, group texting, writing an email, talking on the phone, dialing, gaming, browsing, reading, social media, watching a video, and listening to music. The following paragraphs will provide a further description of these secondary tasks and their main outcomes.

2.2.2 The Impact of Texting on Pedestrians

When examining the studies on texting while walking (Annexe A), it is clear that numerous studies have focused on this secondary task, particularly on pedestrian walking behaviors and safety. The majority of these studies have highlighted the significant impact that texting has on pedestrian walking behaviors and their safety (Almajid et al., 2023; P. L. Chen & Pai, 2018a; Chopra et al., 2018; Haga et al., 2016; Mourra et al., 2020; Pelicioni et al., 2023; Pourchon et al., 2017; Raoniar & Maurya, 2023; Scopatz & Zhou, 2016; Silva et al., 2017; Sobrinho-Junior et al., 2022; Stavrinos et al., 2018; Syazwan et al., 2017; Yadav & Velaga, 2022). Among these studies three literature reviews conducted by Scopatz & Zhou (2016), Stavrinos et al. (2018), and Yadav & Velaga (2022) have found that texting significantly impacts pedestrian walking behaviors and safety. Another recent meta-analysis conducted by Simmons et al. (2020) identified texting as the most detrimental task while walking, yielding significant results on most behavioral measures. However, one behavioral measure yielded non-significant results, leading this study to be categorized as mixed results in Annexe A. Overall, this collective body of research highlights the detrimental impacts that texting while walking has on pedestrians' walking behavior and safety.

Gait is the second most studied outcome of texting while walking. In general, texting was found to significantly impact pedestrians' gait (Bovonsunthonchai et al., 2020; S.-H. Chen et al., 2018; Ferraro et al., 2022; Luo et al., 2023; Pelicioni et al., 2023; Stavrinos et al., 2018; Tian et al., 2018; Yadav & Velaga, 2022; X. Zhang et al., 2023). Within this pool of studies, three literature reviews by Stavrinos et al. (2018), Yadav & Village (2022), and Zhang et al. (2023) have demonstrated that texting significantly reduces pedestrian's gait while walking. However, two studies found mixed results in terms of texting and gait (Hinton et al., 2018; Walsh et al., 2019). Further investigation could provide valuable insights into understanding these nuances and their implications for pedestrian behaviors and safety.

In terms of visual detection, the majority of studies indicate that texting significantly impairs pedestrians' ability to visually detect their surroundings (P. L. Chen & Pai, 2018a; Kim et al., 2022; Wang et al., 2022; Yadav & Velaga, 2022). According to Yadav et al. 's (2022) systematic review, visual distractions such as texting exhibit higher impairment because pedestrians divert their attention off the road and onto their mobile phones. Only one study found effects on visual task performance while texting to not be significant at $p < .05$ (Labonte-LeMoyne et al., 2022), however, it was significant at $p = .078$. In general, the existing literature indicates that texting significantly impairs pedestrians' visual awareness of their surroundings as mobile phones divert attention off the road.

Only four studies were identified evaluating texting and auditory detection of pedestrians' surroundings (P. L. Chen & Pai, 2018a; Davis & Barton, 2017; Haga et al., 2016; Wang et al., 2022). P.L. Chen & Pai (2018)a, Haga et al. (2016), Wang et al. (2022) found that texting significantly influenced pedestrians' auditory detection as participants responded more slowly to auditory stimuli when they were texting while walking. Davis & Barton (2017) did not find texting to significantly impact a participant's ability to detect auditory stimuli, specifically approaching vehicles. More precisely, detection distances in the texting condition were not significantly different from the control condition, where participants were not engaged in any secondary task. Additional research is needed to delve into the nuances surrounding the impacts of texting on pedestrians' auditory detection of their surroundings.

In terms of cognitive processes, only three studies evaluated cognitive processes (Haga et al., 2016; Labonte-LeMoyne et al., 2022; Wang et al., 2022). In Haga et al. 's (2016) study, participants experienced a higher subjective workload while texting and walking. In Wang et al.'s (2022) study, participants experienced significantly higher self-reported cognitive load while texting and walking compared to when they were undistracted. Lastly, participants did not experience significant engagement or cognitive tunneling when texting and walking (Labonte-LeMoyne et al., 2022) as measured by an electroencephalogram (EEG) headset. Given the lack of research on the impacts of texting on pedestrians' cognitive processes, further studies can contribute valuable insight to the understanding of this task type.

Three studies investigated secondary task performance while walking (Chopra et al., 2018; Hinton et al., 2018; Pelicioni et al., 2023). Chopra et al. (2018) observed significantly lower texting performance while participants walked. Similarly, Pelicioni et al. (2023) reported a significant decrease in texting accuracy while participants walked. In contrast, Hinton et al. ‘s (2018) study reported mixed results as participants texting accuracy remained constant across conditions but their typing speed was significantly slower when walking. Taken together, the results suggest that texting while walking does have an effect on task performance. However, as results from Hinton et al.’s (2018) study show mixed results, additional research could address these nuances and deepen our understanding of its effects on pedestrians.

2.2.3 The Impact of Group Texting on Pedestrians

Group texting presents different challenges compared to one-on-one texting as it could introduce additional social elements such as the feeling of not wanting to be left out or missing out on conversations (Marengo et al., 2021). Despite its unique challenges, research on the impacts of group texting remains limited. As seen in Annexe A, only two studies have studied group texting. A recent study found that group texting significantly impacts a pedestrian's walking behavior (Mourra et al., 2020). Another recent study examined how group texting affects pedestrians’ visual detection abilities and cognitive processes (Labonte-LeMoyne et al., 2022). Results revealed that group texting significantly impairs a pedestrian's ability to visually identify another pedestrian’s walking direction, while its effects on cognitive engagement yielded mixed results. Further research is needed to understand the impacts of group texting on pedestrians. This should include investigating how it affects gait, auditory detection, and secondary task performance, since no research has been conducted on these tasks.

2.2.4 The Impact of Writing an Email on Pedestrians

One literature review (Scopatz & Zhou, 2016) and one newer study (Labonte-LeMoyne et al., 2022) examined the effects of writing an email while walking. In Scopatz & Zhou’s (2016) literature review, writing an email was found to significantly impact pedestrians walking behaviors and safety. However, another study looking at participants' visual ability to detect another walker’s direction and their levels of cognitive engagement yielded non-significant results (Labonte-LeMoyne et al., 2022) (Labonte-LeMoyne et al., 2022). Results seem to indicate that writing an email could impact pedestrians. Additional research could help support these findings and deepen our understanding of its implications on pedestrians. Since there is no existing research on pedestrians' gait, auditory detection, and secondary task performance, studies should focus on these areas to expand our understanding of this task type.

2.2.5 The Impact of Talking on the Phone on Pedestrians

Talking on the phone is the second most studied task following texting. The majority of the studies reported that the action of talking on the phone while walking significantly impacts on pedestrian walking behavior and safety (Dam et al., 2023; Li & Ming, 2016; Raoniar & Maurya, 2023; Scopatz & Zhou, 2016; Sobrinho-Junior et al., 2022; Stavrinos et al., 2018; Syazwan et al., 2017). Within these studies, two literature reviews by Scopatz & Zhou (2016) and Stavrinos et al. (2018) mention that talking on the phone alters pedestrian walking behavior and compromises their safety. However, two other literature reviews reported mixed results regarding this relationship (Simmons et al., 2020; Yadav & Velaga, 2022), and one study found no significant results (Yuanyuan et al., 2017). Research on the relationship of talking on the phone and pedestrians' walking behavior show conflicting results. Further research may be needed to gain deeper insight into the nuances of talking on the phone while walking.

Extensive research has examined the impact of talking on the phone on pedestrian gait. One literature review by Stravinos et al. (2018) and one newer study by Bovonsunthonchai et al. (2020) concluded that talking on the phone significantly impacts pedestrian gait. However, a literature review by Yadav & Velaga (2022) and a separate study by Walsh et al. (2019) yielded mixed results. In contrast, a literature review on pedestrian gait by X. Zhang et al. (2023) and another study by Yuanyuan et al. (2017) found no significant changes in gait when pedestrians were talking on their phones. Additionally, the same literature review on gait by X. Zhang et al., (2023) examined pedestrians dialing a phone number while walking and also found no significant results. Given the variability in these results, additional research could provide a more comprehensive understanding of the impact of talking on the phone on pedestrian gait.

Regarding pedestrians' ability to visually detect their surroundings, only one study reported that talking on the phone significantly impacts pedestrians' (Wang et al., 2022). However, Yadav & Velaga's (2022) literature review and a separate study by Chen & Pai, (2018a) yielded mixed results. Further investigation into this relationship could help respond to the inconsistencies observed across studies.

All studies consistently reported that talking on the phone significantly impacts auditory detection (P. L. Chen & Pai, 2018a; Davis et al., 2021; Davis & Barton, 2017; Wang et al., 2022), as this activity requires pedestrians to use their auditory resources, consequently diminishing their ability to detect auditory stimuli in their environment.

Limited research has investigated pedestrians' cognitive processes while simultaneously talking on the phone and walking. Nevertheless, this study found a significant impact on pedestrians' cognitive processes under these conditions (Wang et al., 2022). Future studies could investigate pedestrian's cognitive processes while talking on the phone to gain a comprehensive understanding of its implications. In terms of secondary task performance while talking on the phone, no studies have explored this yet and could be an interesting path for future studies.

2.2.6 The Impact of Gaming on Pedestrians

Regarding pedestrian walking behaviors and safety, one literature review (Scopatz & Zhou, 2016) and three other studies reveal that gaming significantly impairs pedestrians' walking behavior and safety (P.-L. Chen & Pai, 2018; Mourra et al., 2020; Pourchon et al., 2017). Additionally, engaging in mobile games while walking is shown to significantly modify pedestrians' gait behavior (Bovonsunthonchai et al., 2020; Luo et al., 2023). Two studies have reported that playing mobile games while walking significantly impacts pedestrians' ability to visually detect their surroundings (P. L. Chen & Pai, 2018a; Labonte-LeMoyne et al., 2022). Furthermore, Chen & Pai (2018a) found that gaming significantly impairs the ability to detect auditory signals in the environment. Notably, Labonte-LeMoyne et al. (2022) also investigated pedestrians' cognitive processes and found significant results. One interesting conclusion of Labonte-LeMoyne et al. (2022) was that gaming led to the most deteriorating pedestrian performance compared to texting. Despite indications that gaming is riskier than other commonly studied tasks such as texting, texting remains widely regarded as the most dangerous task type while walking. Overall, gaming has received moderate attention and its results show that gaming significantly alters pedestrians walking behavior, safety, gait, visual detection, auditory detection and cognitive processes. No research has been conducted on task performance of gaming while walking which could be an interesting path to follow for future research.

2.2.7 The Impact of Browsing on a Mobile Phone on Pedestrians

Two studies found that browsing on your phone while walking significantly influenced pedestrians' walking behavior and safety (Li & Ming, 2016; Scopatz & Zhou, 2016). However, a meta-analysis by Simmons et al. (2020) reported mixed results. Two observational studies reported that participants who were looking at their screens while crossing the road did significantly impact their walking behaviors and safety (Yuanyuan et al., 2017; H. Zhang et al., 2019). Another meta-analysis investigated pedestrians' gait while browsing on their phones and found no significant results (X. Zhang et al., 2023). Chen & Pai's (2018a) study reported mixed results concerning visual detection and found no significant effects on auditory detection. Overall, research on pedestrians' behavior, safety, gait, and visual detection while browsing on a mobile phone yielded mixed results, highlighting the need for further investigation. Additionally, research has not investigated the impact of browsing on pedestrians' cognitive processes and secondary task performance.

2.2.8 The Impact of Reading on Pedestrians

A literature review conducted by Scopatz & Zhou (2016) revealed that reading has a significant impact on pedestrians' walking behaviors and safety. Concerning gait, only one study yielded significant results (Luo et al., 2023), while another study reported mixed results (Walsh et al., 2019). A literature review on pedestrians' gait revealed that reading does not yield any significant effects (X. Zhang et al., 2023). Regarding visual detection, reading was found to not have significant results in one study (Labonte-LeMoyne et al., 2022). Similarly, the same study found no significance of reading on participants' cognitive processes while walking (Labonte-LeMoyne et al., 2022). In general, according to the literature review by Scopatz & Zhou's (2016), reading significantly impacts pedestrians' walking behaviors and safety. However, its effects on gait, visual detection, and cognitive processes is less clear and could benefit from further research.

Furthermore, future work should focus on studying the effects of reading on pedestrians' auditory detection and secondary task performance as no research has been conducted in this area.

2.2.9 The Impact of Social Media & Short Videos on Pedestrians

Research on the impacts of social media use while walking is limited. One study investigated the effects of social media and found significant impacts on pedestrians' walking behaviors and safety (Gruden et al., 2022). Another study found that social media significantly impacted pedestrians' inattentional blindness, as they did not notice a clown walking in the opposite direction and lacked situational awareness, being unable to remember how many seconds remained before crossing the street (P. L. Chen & Pai, 2018a). In contrast, this study found that social media did not significantly impact their auditory detection of a national anthem playing in the background (P. L. Chen & Pai, 2018a). Given the widespread use of social media in people's daily lives, additional research is needed to further understand its potential risks. Similarly, watching short videos while walking has received limited attention, with only one study by Bovonsunthonchai et al. (2020) demonstrating that this task significantly impacts a pedestrian's gait. In today's world watching short-form videos on social media is common, and further research regarding these two tasks is crucial to understand the potential risks that pedestrians may face. Future research could also examine the effects of gait, cognitive processes, and secondary task performance since no studies have examined this.

2.2.10 The Impact of Listening to Music on Pedestrians

Numerous studies have investigated the impact of listening to music while walking, yielding various results. One literature review (Scopatz & Zhou, 2016) and three other studies reported significant effects of listening to music on pedestrians' walking behaviors and safety (Li & Ming, 2016; Raoniar & Maurya, 2023; Syazwan et al., 2017). Another literature review (Stavrinos et al., 2018) and another recent study yielded mixed results (Dam et al., 2023). Two literature reviews (Simmons et al., 2020; Yadav & Velaga, 2022) and another study found no significant impact on pedestrians' walking behaviors and safety (H. Zhang et al., 2019). Notably, across all studies, listening to music did not significantly influence pedestrians' gait (Bovonsunthonchai et al., 2020; Stavrinos et al., 2018; Yadav & Velaga, 2022; X. Zhang et al., 2023). Among the studies examining visual detection, one reported a significant impact on pedestrians' ability to detect their surroundings (Wang et al., 2022), one study yielded mixed results (P. L. Chen & Pai, 2018b), while another literature review found no significant results (Yadav & Velaga, 2022). Regarding auditory detection, two studies indicated a significant impact of listening to music (P. L. Chen & Pai, 2018a; Wang et al., 2022), while another yielded mixed results (Davis et al., 2021). Lastly, only one study explored cognitive processes while listening to music while walking, revealing significant effects (Wang et al., 2022). In summary, research on listening to music while walking shows that the effects on pedestrian behaviors are varied, while gait is clearly not affected. Studies on visual detection, auditory detection, and cognitive processes remain limited and could benefit from further research. Additionally, no studies have examined the effects of listening to music on secondary task performance.

2.3 Comparing Secondary Task Types on Pedestrian Performance

Out of the 34 studies identified, only 15 of them directly compared different task types between each other (see Annexe B). The following sections examine the body of research comparing different mobile task types. Specifically, the task types examined will include texting, group texting, writing an email, talking on the phone, dialing, gaming, browsing, reading, social media, watching a video, and listening to music.

2.3.1 Studies Comparing Texting to Other Secondary Task Types

Regarding texting, this task type has been extensively compared to activities such as talking on the phone (Bovonsunthonchai et al., 2020; P. L. Chen & Pai, 2018a; Davis & Barton, 2017; Raoniar & Maurya, 2023; Scopatz & Zhou, 2016; Simmons et al., 2020; Stavrinos et al., 2018; Wang et al., 2022; Yadav & Velaga, 2022; X. Zhang et al., 2023), gaming (Bovonsunthonchai et al., 2020; P. L. Chen & Pai, 2018a; Labonte-LeMoyne et al., 2022; Luo et al., 2023; Mourra et al., 2020; Pourchon et al., 2017; Scopatz & Zhou, 2016), and listening to music (Bovonsunthonchai et al., 2020; P. L. Chen & Pai, 2018a; Raoniar & Maurya, 2023; Scopatz & Zhou, 2016; Simmons et al., 2020; Stavrinos et al., 2018; Wang et al., 2022; Yadav & Velaga, 2022; X. Zhang et al., 2023). Texting has been less frequently compared to other mobile task types, such as group texting (Labonte-LeMoyne et al., 2022; Mourra et al., 2020), writing emails (Labonte-LeMoyne et al., 2022; Scopatz & Zhou, 2016), browsing (P. L. Chen & Pai, 2018a; Scopatz & Zhou, 2016; Simmons et al., 2020; X. Zhang et al., 2023), and reading (Labonte-LeMoyne et al., 2022; Luo et al., 2023; Scopatz & Zhou, 2016; X. Zhang et al., 2023). Dialing (X. Zhang et al., 2023), social media (P. L. Chen & Pai, 2018a), and watching a video (Bovonsunthonchai et al., 2020) each have only one study that compared their outcomes to texting. Overall, texting emerges as the most extensively compared mobile task type to other activities. Nevertheless, further studies are needed to compare task types such as dialing, social media, and watching videos to gain deeper insight into their distinctions relative to texting.

2.3.2 Studies Comparing Group Texting to Other Secondary Task Types

Group texting has been compared to various activities, including texting (Labonte-LeMoyne et al., 2022; Mourra et al., 2020), writing emails (Labonte-LeMoyne et al., 2022), gaming (Labonte-LeMoyne et al., 2022; Mourra et al., 2020) and reading (Labonte-LeMoyne et al., 2022). No studies have compared group texting to tasks such as talking on the phone, dialing, browsing, social media, watching a video, or listening to music. Additional studies are necessary to explore the differences between group texting and other task types that have been less studied such as talking on the phone, dialing, browsing, social media, watching a video, and listening to music.

2.3.3 Studies Comparing Writing an Email to Other Secondary Task Types

Writing an email has been compared to texting (Labonte-LeMoyne et al., 2022; Scopatz & Zhou, 2016), group texting (Labonte-LeMoyne et al., 2022), talking on the phone (Scopatz & Zhou, 2016), gaming (Labonte-LeMoyne et al., 2022; Scopatz & Zhou, 2016), browsing (Scopatz & Zhou, 2016), reading (Labonte-LeMoyne et al., 2022; Scopatz & Zhou, 2016), and listening to music (Scopatz & Zhou, 2016). Currently, there is no existing literature of studies comparing writing an email to dialing, social media, and watching a video. There is a need for future research to compare writing an email to secondary mobile task types such as dialing, social media, and watching a video.

2.3.4 Studies Comparing Talking on the Phone to Other Secondary Task Types

Many studies regarding pedestrians talking on the phone have been compared to the secondary tasks of texting (Bovonsunthonchai et al., 2020; P. L. Chen & Pai, 2018a; Davis & Barton, 2017;

Raoniar & Maurya, 2023; Scopatz & Zhou, 2016; Simmons et al., 2020; Stavrinos et al., 2018; Wang et al., 2022; Yadav & Velaga, 2022; X. Zhang et al., 2023) and listening to music (Bovonsunthonchai et al., 2020; P. L. Chen & Pai, 2018a; Davis et al., 2021; Raoniar & Maurya, 2023; Scopatz & Zhou, 2016; Simmons et al., 2020; Stavrinos et al., 2018; Wang et al., 2022; Yadav & Velaga, 2022; X. Zhang et al., 2023). Additionally, writing an email (Scopatz & Zhou, 2016), dialing (X. Zhang et al., 2023) and reading (Scopatz & Zhou, 2016; X. Zhang et al., 2023) have also been widely studied, as evidenced in their inclusion in literature reviews. Furthermore, other secondary task types such as gaming (Bovonsunthonchai et al., 2020; P. L. Chen & Pai, 2018a; Scopatz & Zhou, 2016), social media (P. L. Chen & Pai, 2018a), and watching a video (Bovonsunthonchai et al., 2020) have also been studied though to a lesser extent. Among secondary task types, and group texting are the only two that have not been studied in comparison to talking on the phone. Additional research is needed to investigate group texting, watching the screen, social media, and watching videos in comparison to talking on the phone.

2.3.6 Studies Comparing Dialing to Other Secondary Task Types

One literature review examined the impacts of dialing compared to other secondary task types such as texting, talking on the phone, browsing, reading, and listening to music (X. Zhang et al., 2023). However, no studies have compared dialing a phone number to other secondary task types such as group texting, writing email, gaming, social media, and watching a video. Further research on these secondary task types could highlight the different implications for pedestrians.

2.3.7 Studies Comparing Gaming to Other Secondary Task Types

Gaming has been extensively compared to texting (Bovonsunthonchai et al., 2020; P. L. Chen & Pai, 2018a; Labonte-LeMoyne et al., 2022; Luo et al., 2023; Mourra et al., 2020; Pourchon et al., 2017; Scopatz & Zhou, 2016), with subsequent comparisons often involving talking on the phone (Bovonsunthonchai et al., 2020; P. L. Chen & Pai, 2018a; Scopatz & Zhou, 2016) and listening to music (Bovonsunthonchai et al., 2020; P. L. Chen & Pai, 2018a; Scopatz & Zhou, 2016). Gaming has also been compared to other secondary task types such as group texting (Labonte-LeMoyne et al., 2022; Mourra et al., 2020), writing an email (Labonte-LeMoyne et al., 2022; Scopatz & Zhou, 2016), browsing (P. L. Chen & Pai, 2018a; Scopatz & Zhou, 2016), reading (Labonte-LeMoyne et al., 2022; Luo et al., 2023; Scopatz & Zhou, 2016), social media (P. L. Chen & Pai, 2018a) and watching a video (Bovonsunthonchai et al., 2020). However, no studies have examined the relationship between gaming and other secondary task types such as dialing which could benefit from further investigation. Additionally, previously mentioned task types such as group texting, social media, and watching a video have received limited research and could benefit from further investigation.

2.3.8 Studies Comparing Browsing on a Mobile Phone to Other Secondary Task Types

Browsing on a mobile phone has mostly been compared to texting (P. L. Chen & Pai, 2018a; Scopatz & Zhou, 2016; Simmons et al., 2020; X. Zhang et al., 2023), talking on the phone (P. L. Chen & Pai, 2018a; Scopatz & Zhou, 2016; Simmons et al., 2020; X. Zhang et al., 2023) and listening to music (P. L. Chen & Pai, 2018a; Scopatz & Zhou, 2016; Simmons et al., 2020; X. Zhang et al., 2023). It's worth noting that the literature reviews conducted by Scopatz & Zhou (2016), Simmons et al. (2020), X. Zhang et al. (2023) provide comprehensive analyses of these comparisons and are particularly important due to their depth of research. Additionally, other secondary task types such as writing an email (Scopatz & Zhou, 2016), dialing (X. Zhang et al., 2023), gaming (P. L. Chen & Pai, 2018a; Scopatz & Zhou, 2016), reading (Scopatz & Zhou, 2016; X. Zhang et al., 2023) and social media (P. L. Chen & Pai, 2018a) have also been compared to pedestrians browsing on their mobile phones. However, no research has been conducted to compare browsing to other activities such as group texting, and watching a video, indicating a significant gap in the literature that requires further investigation. Furthermore, it's important to highlight that only one study by Chen & Pai (2018a) has examined the relationship between browsing and social media. Future studies could delve deeper into the different implications between browsing and social media while walking.

2.3.8 Studies Comparing Reading to Other Secondary Task Types

The act of reading while walking has been mostly compared to texting (Labonte-LeMoyne et al., 2022; Luo et al., 2023; Scopatz & Zhou, 2016; X. Zhang et al., 2023), gaming (Labonte-LeMoyne et al., 2022; Luo et al., 2023; Scopatz & Zhou, 2016), and listening to music (Scopatz & Zhou, 2016; X. Zhang et al., 2023). Other secondary task types were also studied such as group texting (Labonte-LeMoyne et al., 2022), writing an email (Labonte-LeMoyne et al., 2022; Scopatz & Zhou, 2016), talking on the phone (Scopatz & Zhou, 2016; X. Zhang et al., 2023), dialing (X. Zhang et al., 2023), and browsing (Scopatz & Zhou, 2016; X. Zhang et al., 2023). Studies comparing reading with social media or watching videos could benefit from further research.

2.3.9 Studies Comparing Social Media and Watching Videos to Other Secondary Task Types

Social media has been compared to secondary task types such as texting, talking on the phone, gaming, browsing, and listening to music (P. L. Chen & Pai, 2018a). Social media has not been compared to group texting, writing an email, dialing, reading, watching a video, and watching the screen. It is worth mentioning that only one study conducted by Chen & Pai (2018a) has investigated social media and its outcomes compared to various other secondary task types. Further research is needed on social media use while walking, in comparison with other tasks, in order to better understand its implications for pedestrians. Similarly, only one study investigated the comparative outcomes of watching videos while walking to other task types (Bovonsunthonchai et al., 2020). This study compared watching a video to texting, talking on the phone, gaming, and listening to music. Watching a video while walking has not been compared to the following secondary task types: group texting, writing an email, dialing, browsing, reading, social media, and watching the screen. Further studies are needed on pedestrians watching videos while walking in comparison to other task types to improve the understanding and impact it has on pedestrians.

2.3.10 Studies Comparing Listening to Music to Other Secondary Task Types

Listening to music has been vastly compared to texting (Bovonsunthonchai et al., 2020; P. L. Chen & Pai, 2018a; Raoniar & Maurya, 2023; Scopatz & Zhou, 2016; Simmons et al., 2020; Stavrinos et al., 2018; Wang et al., 2022; Yadav & Velaga, 2022; X. Zhang et al., 2023) and talking on the phone (Bovonsunthonchai et al., 2020; P. L. Chen & Pai, 2018a; Davis et al., 2021; Raoniar & Maurya, 2023; Scopatz & Zhou, 2016; Simmons et al., 2020; Stavrinos et al., 2018; Wang et al., 2022; Yadav & Velaga, 2022; X. Zhang et al., 2023) . Other studies have compared themselves to listening to music, secondary task types such as writing an email (Scopatz & Zhou, 2016), dialing (X. Zhang et al., 2023), gaming (Bovonsunthonchai et al., 2020; P. L. Chen & Pai, 2018a; Scopatz & Zhou, 2016), browsing (P. L. Chen & Pai, 2018a; Scopatz & Zhou, 2016; Simmons et al., 2020; X. Zhang et al., 2023), reading (Scopatz & Zhou, 2016; X. Zhang et al., 2023), social media (P. L. Chen & Pai, 2018a), and watching a video (Bovonsunthonchai et al., 2020). No studies have compared listening to music to group texting. Future studies could investigate the act of group texting while walking, or other less-studied secondary tasks such as social media or watching a video. This would help further understand their differences.

2.4 Summary of Secondary Task Type Impacts on Pedestrian Performance

The objective of this literature review is to examine the impact of mobile multitasking on pedestrians, considering various mobile tasks and their effects. A comprehensive search resulted in a total of 34 articles, including five review articles that identify different secondary task types and their effects on pedestrians.

Texting emerged as the most extensively researched task type, consistently showing significant impacts across various outcomes of pedestrian performance. Talking on the phone and listening to music have also been extensively researched but appear to be less impactful than texting. Other less explored tasks such as gaming, have shown significant effects across all studies. One study highlighted that gaming can impair pedestrians more severely than texting (Labonte-LeMoyne et al., 2022), emphasizing the necessity for further research into the risk associated with gaming while walking. Similarly, social media use and watching videos have received limited research but have shown to significantly impair pedestrian performance. Given the increasing prevalence of these activities, particularly on platforms such as TikTok and Instagram, additional research in these areas is crucial for understanding their implications on pedestrian safety.

When reviewing the literature, six main outcomes on pedestrian performance were identified: pedestrian walking behaviors and safety, gait, visual detection, auditory detection, cognitive processes, and secondary task performance. Studies on pedestrian walking behaviors and safety were the most researched, followed by those focusing on pedestrian gait. Visual detection and auditory detection received moderate attention, whereas studies on pedestrians' cognitive processes and their secondary task performance were less common. Studying these outcomes in further detail could provide a comprehensive understanding of how pedestrians are impacted when using mobile phones while walking.

Of the 34 articles retrieved for this literature review, only 15 are comparative studies. Future studies should focus on conducting more comparative studies of tasks to fully understand the differing outcomes and implications on pedestrian safety and behaviors. Most of the comparative studies included tasks like texting, talking on the phone, and listening to music. The least explored tasks in comparative studies were group texting, social media, and watching videos. Further comparative studies should be implemented with these less studied tasks. Especially those tasks related to social media and videos. Today, they are widely used by individuals, and short-formed videos have been added to many social media platforms such as TikTok, Instagram, YouTube, Facebook. Future studies should focus on studying this new phenomenon as it could have risky consequences on pedestrians while crossing the road.

Chapter 3: Research Model

This chapter presents the development of the hypotheses that led to the construction of the research model used in this thesis. It begins with section 3.1, which provides a brief overview of the theories used to develop the research model. In section 3.2, the potential effects of different task types on cognitive absorption are explored. Section 3.3 examines how cognitive absorption could influence recall accuracy of the environment. Section 3.4 delves into the potential relationship between cognitive absorption and recall accuracy of time. Section 3.5 will present the potential direct effects of task type on recall accuracy of time and environment. Finally, the complete research model is presented in section 3.6.

3.1 Model Development

To answer the research questions, a model was developed to examine how different task types can impact a pedestrian's ability to recall their environment and recall time, while also evaluating how cognitive absorption mediates this relationship. In the hypothesis development that follows, the study draws on three existing theories, namely the theories of cognitive absorption, inattentional blindness, and time perception. The research model (see Figure 1) and its accompanying hypotheses are explained in the sections below.

3.2 The effects of Task Type on Cognitive Absorption

As seen in the literature, pedestrians who mobile multitask while walking are more likely to be injured or involved in an accident (Retting & Consulting, 2017; Thompson et al., 2013). This may be due to pedestrians becoming absorbed in their phones. Therefore, this study aims to examine the potential effects of cognitive absorption on pedestrians using their mobile phones while walking. Cognitive absorption is described as a state of deep involvement with a software (Agarwal & Karahanna, 2000). Cognitive absorption is exhibited through the following five dimensions: temporal dissociation, focused immersion, heightened enjoyment, control, and curiosity (Agarwal & Karahanna, 2000). The first dimension, temporal dissociation, refers to an individual's inability to register the passage of time while being engaged in an interaction (Agarwal & Karahanna, 2000). Focused immersion describes a state of total engagement in an interaction where other attentional demands are ignored (Agarwal & Karahanna, 2000). Heightened enjoyment reflects the pleasurable aspects of an interaction (Agarwal & Karahanna, 2000). Control is when an individual perceives being in charge of their interaction (Agarwal & Karahanna, 2000). Finally, curiosity reflects the extent to which the experience stimulates an individual's sensory and cognitive curiosity (Agarwal & Karahanna, 2000). Labonte et al. (2022) suggested that future research should examine outcomes such as cognitive absorption in a mobile device task and investigate its impacts on pedestrians. In this study's model, it is hypothesized that certain task types would exhibit higher levels of cognitive absorption than others.

Based on the literature review conducted, it was decided to examine specific task types such as texting, gaming, reading and social media. These task types were chosen because they are commonly used on the phone. Additionally, some literature has found effects of these types of multitasking (Gruden et al., 2022; Scopatz & Zhou, 2016; Yadav & Velaga, 2022), but rarely compares them all together. From the literature review, it was shown that pedestrians who text or play video games on their mobile phone while walking are significantly impacted. This finding prompted the decision to include these activities in the study. In addition, reading was included as a task type with potentially less impact, and social media was added because it is less studied in the literature. These task types will be discussed in further detail in the following sections, along with their possible effects on cognitive absorption.

3.2.1 Gaming & Cognitive Absorption

As indicated in the literature review, gaming has been shown to significantly impact pedestrians. In this study, it is anticipated that gaming will exhibit higher cognitive absorption in pedestrians compared to other certain task types, given the immersive features of mobile games.

Games are often designed to be immersive in order to monetize users' prolonged interactions through advertisements or purchases of additional features of the game (Montag et al., 2019). For example, many games follow a "Freemium" model in which users can download the basic version of the game for free and spend money for extra features or the premium version of the game (Montag et al., 2019). Several techniques are used to increase user *flow* - becoming deeply immersed or absorbed in the game such that they lose track of time and space - to prolong user interaction with the game (Montag et al., 2019).

Many mobile games are designed to be very fast-paced which can highly absorb users into their mobile games experience. For example, in the game “Tetris” blocks of different shapes continually fall, making users take quick decisions on how to position them. The player loses the game when too many blocks are present. As the game progresses, the pace increases and the user must continually interact and remain attentive to progress to the next level and avoid losing points or status. As a result of this ongoing attention and interaction, users engaged in fast-paced games may experience higher levels of absorption.

Mobile games are often designed to have extrinsic rewards in order to make users come back for more (Wu & Santana, 2022). Some examples of extrinsic gaming elements can include achievements, badges, points, rewards, feedback and challenges that can enforce long-term retention in users (Birk et al., 2016; Wu & Santana, 2022). Users spend more time playing the game in order to reach the next level and receive more rewards, which may result in higher levels of absorption.

Games also include intrinsic rewards and are designed to engage users emotionally to maintain their interest (Wu & Santana, 2022). Intrinsic gaming elements are composed of groups, messages, blogs, chats, progressive bars, levels, leaderboards, profiles, notification controls, avatars, etc… Games can evoke positive emotions, providing a fun break from boredom and offering an escape from one’s reality (Boyle et al., 2012). Games can also play on negative emotions. For example, research has found that the near-misses of the mobile game Candy Crush, and the associated frustration had the strongest effect on users’ motivation to continue playing the game (Larche et al., 2017).

These various characteristics of mobile games may make them more cognitively absorbing, to the point where they can develop an addictive nature and lead to serious addiction (André et al., 2020;

Montag et al., 2019, 2021). Thus, mobile gaming is expected to result in higher cognitive absorption than other mobile tasks during pedestrian multitasking.

3.2.2 Texting & Cognitive Absorption

As indicated in the literature review, texting has been shown to significantly impact pedestrians. Numerous elements present on texting platforms could further absorb users in their mobile phones. A primary distraction that draws users into their mobile phones is notifications, which alert users through either ringing or vibrating. These notifications create an attentional cost on mobile phone users (Stothart et al., 2015) diverting their attention away from their surroundings and towards their mobile device. The act of texting is also a very interactive task that requires users to engage with their phones by typing messages with their fingers. While texting users could be highly absorbed with their phones as they have to focus on simultaneously writing their messages and ensure correct spelling.

Additionally, numerous features create a certain amount of social pressure associated with texting, resulting in users becoming deeply absorbed in their phones. For example, the "double tick" feature on WhatsApp indicates when a message is delivered and read, creating social pressure by nudging users to respond quickly to their peers (Montag et al., 2019). Many other messaging platforms, such as iPhone's iMessage and Facebook Messenger, have adopted this feature. Another study exploring social pressure in mobile instant messaging platforms revealed that mobile phone users expect fast responses (Pielot et al., 2014). As a result of these expectations, users may feel pressured to respond faster to avoid keeping the other person waiting, thereby further diverting their attention into their phones.

Another important social aspect that could entice users to quickly respond to their text messages is the concept of FoMO (Fear of Missing Out) (Montag et al., 2019). FoMO refers to the urge of staying constantly connected with others' activities and the anxiety of missing out on something within one's social network (Montag et al., 2019). Therefore, users experiencing FoMO could be more absorbed into their phones to ensure they never miss text messages sent by their peers. All of these social pressure elements related to texting draws users' attention to their mobile phones, leading them to potentially becoming highly absorbed in their devices.

The pace of conversation can also be influenced externally by the recipient of the messages. For instance, if the user is communicating to an important individual such as their boss, they might respond more promptly. This could potentially absorb users into their phones as they feel compelled to respond quickly to their peers.

Overall, texting encompasses numerous features and elements that may deeply absorb users into the mobile world, diverting their attention away from their surroundings. Consequently, it is anticipated that texting may create higher levels of cognitive absorption compared to other certain task types.

3.2.3 Reading & Cognitive Absorption

Reading may have less influence on cognitive absorption in several ways. To begin with, reading on a mobile phone is less interactive than the other tasks mentioned, as the user only needs to scroll down to continue reading or select another article by tapping their finger. Reading is also less attention-seeking, as there are no notifications that call for your attention like text message or dynamic elements in gaming that demand immediate attention. Additionally, reading an article lacks the social pressure present in texting, as it is an individual task with no involvement of other people. Reading is also a slower activity as users can read at their own pace. This task could also be perceived as less "fun" than the other tasks, potentially resulting in lower user absorption. Therefore, it is expected that reading will exhibit the lowest cognitive absorption compared to the other task types mentioned.

3.2.4 Short-form social media videos & Cognitive Absorption

As seen in the literature, texting and gaming seem to significantly impact pedestrians when mobile multitasking while walking. Given the limited research on social media, its effects on pedestrians remain uncertain. This study aims to further investigate this task type in order to understand its consequences. Social media platforms such as Instagram embody various features that can captivate users and keep them absorbed with their phones. Some examples of such features include messaging your friends, scrolling through short-form videos, reading captions, and liking pictures from your feed of your friends, celebrities or companies. This study will only focus on short-form videos, a relatively new way to consume social media content. This type of content has grown increasingly popular over the last couple of years and represents 90% of internet traffic in 2024 (*20+ Interesting Short Form Video Statistics & Trends (2024)*, 2024). Ever since TiktTok came out in 2016 (*TikTok Revenue and Usage Statistics (2024) - Business of Apps*, 2024), many various other social media platforms have adopted a similar style of content like for example Instagram, Facebook, YouTube.

This study will focus on Instagram's short form videos called "Reels". The videos could potentially be absorbing due to various characteristics of the social media platform. It is important to note that social media platforms such as Instagram, are designed to be highly immersive capturing users' attention for extended periods of time. The goal for social media companies is to make users stay as long as possible on their platforms to gain insights on their users and generate revenue through microtargeting and advertisements (Montag et al., 2021). A feature used by designers to prolong the usage time of users is the endless scrolling of videos (Montag et al., 2019). Additionally, the application has a strong machine learning algorithm that shows users of the application what they like (Montag et al., 2019) therefore resulting in the gratification of an individual's needs (Montag et al., 2021). As users are shown more content suited for them, they are more likely to stay on the application longer and further immersed. These features can potentially lead to addictive behaviors (Montag et al., 2021), causing users to become further immersed in their phones and prolonging their stay on the platform.

There is also an aspect of social pressure relating to watching short-form videos on social media platforms. The design of these platforms can make users experience FoMO (Fear of Missing Out) (Montag et al., 2021) as users don't want to miss what is happening on their social network. For example, users could not want to miss the latest trends or challenges that their social network is participating in (Montag et al., 2021). As users want to stay informed about what is happening on their social network, they may prolong their stay and watch many videos, becoming further absorbed into the platform.

Certain characteristics of short-form social media videos might result in them being less cognitively absorbing in comparison to other task types. For example, compared to gaming or texting, users interact less with the screen when watching short-form videos, as they only need to swipe up or down or tap to like a video. Videos can also be paused or controlled, allowing users to take their time watching them. Users also have the ability to rewatch videos, ensuring they don't miss any important information, unlike games which could result in losing points.

Given these various potential effects of short-form videos, the relationship between this type of multitasking and cognitive absorption remains unclear. Further research is needed to better understand how this type of task can impact a user's cognitive absorption. Overall, users who engage with short-formed social media videos are expected to experience some level of cognitive absorption.

After reviewing the task types of texting, gaming, reading and social media short-form videos, the following hypotheses are presented:

H1: The type of task pedestrians engage in while mobile multitasking will influence cognitive absorption in the following ways:

H1a: The types of tasks pedestrians engage in while mobile multitasking, such as gaming or texting, will lead to higher levels of cognitive absorption.

H1b: The types of tasks pedestrians engage in while mobile multitasking, such as reading or social media, will lead to lower levels of cognitive absorption.

H1c: There will be a relationship between pedestrians multitasking with short-formed social media videos and cognitive absorption.

3.3 The effects of Cognitive Absorption on Recall Accuracy of Environment

As mentioned previously, cognitive absorption is defined as a state of deep involvement a user has in a software (Agarwal & Karahanna, 2000). Cognitive absorption is composed of the following five dimensions: temporal dissociation, focused immersion, heightened enjoyment, control, and curiosity (Agarwal & Karahanna, 2000). The theory of cognitive absorption can also help us understand effects on task performance. Cognitive absorption suggests that as users become more absorbed in their task, their performance on that specific task improves due to their full immersion. However, in the context of pedestrian multitasking, users must simultaneously engage in the two activities of using their phone and walking. In such a dynamic environment, certain types of tasks may increase absorption in the smartphone task, thereby reducing cognitive resources available for walking. When cognitive resources are diverted away from the walking task, pedestrians may have fewer resources available for environmental awareness. The theory of Inattentional Blindness could explain the visual awareness part of these effects.

Inattentional blindness represents the failure to notice objects in our surroundings when our attention is elsewhere (Mack, 2003; Mack & Rock, 1998; Simons & Chabris, 1999). In the context of mobile multitasking, this represents a pedestrians' inability to accurately recall elements in their environment while using a mobile phone. In this study, the concept of inattentional blindness can be used to explain how cognitive absorption influences the ability to accurately recall their environment. The hypothesis presented is that people that report higher levels of cognitive absorption while walking with their mobile phone will exhibit inattentional blindness and not be able to accurately recall elements in their environment.

H2: Individuals with higher cognitive absorption will exhibit lower recall accuracy of their environment.

3.4 The effects of Cognitive Absorption on Recall Accuracy of Time

When pedestrians engage in mobile multitasking while walking, their levels of absorption in their mobile task can also impact other types of awareness such as a user's perception of time. As one of the dimensions of cognitive absorption states, temporal dissociation can occur to users as they become so absorbed they are unable to register the passage of time while engaged in a mobile interaction (Agarwal & Karahanna, 2000). As users become so deeply immersed in their task, they lose track of time (Montag et al., 2019). The impact of cognitive absorption on an individuals' time perception will be explored. The present study hypothesizes that individuals that rate higher on the cognitive absorption scale will inaccurately recall the time spent on their phones while walking. Hence the following hypothesis is posed:

H3: Individuals with higher cognitive absorption will exhibit lower accuracy of recall of time.

3.5 The direct effects of Task Type on Recall Accuracy of Environment and Time

In addition to the indirect effects of task type on recall accuracy of environment and time through cognitive absorption, there may also be direct effects. Understanding these direct effects is crucial because it can provide a comprehensive overview of how different task types impact pedestrians' recall accuracy, with or without cognitive absorption. Therefore, the following hypotheses are proposed:

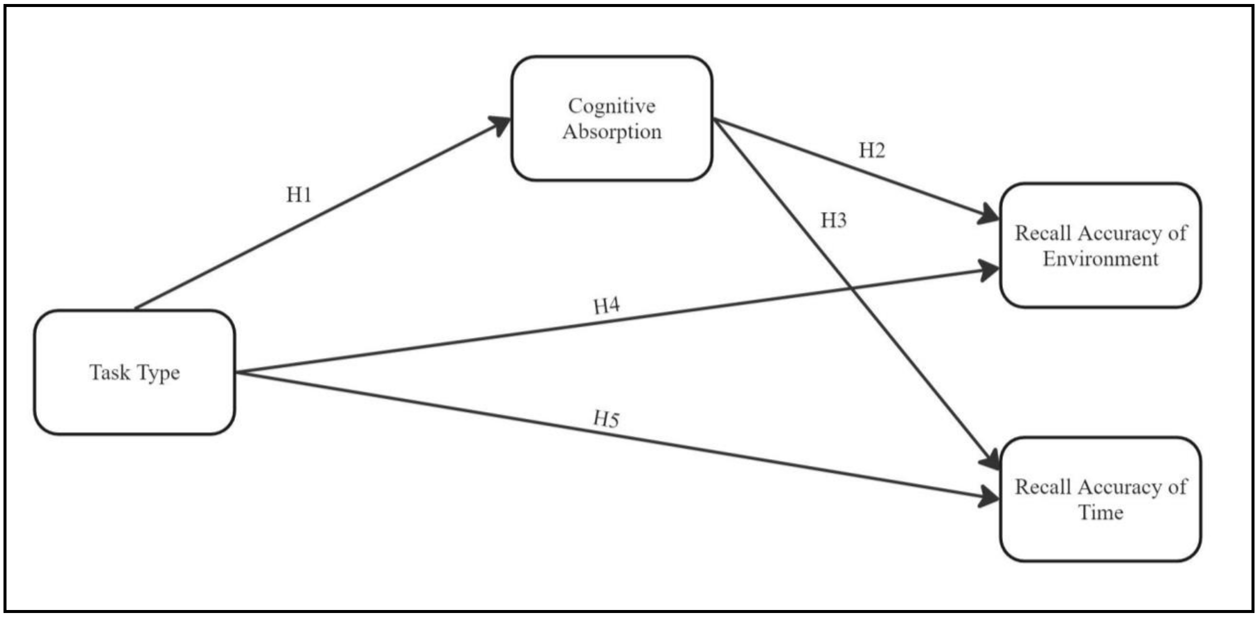
H4: The type of task pedestrians engage in while mobile multitasking will directly affect their recall accuracy of their environment.

H5: The type of task pedestrians engage in while mobile multitasking will directly affect their recall accuracy of time.

3.6 Research Model

The hypotheses discussed are illustrated in the following model (Figure 1). To summarize, the first hypothesis (H1) examines how different task types pedestrians engage in while mobile multitasking will influence cognitive absorption. Specifically, the task types of texting, gaming, reading and social media will be explored. The second hypothesis (H2) investigates the relationship between cognitive absorption and recall accuracy of environment. The third hypothesis (H3) focuses on the relationship between cognitive absorption and recall accuracy of time. The fourth hypothesis (H4) addresses the direct relationship between task type and recall accuracy of environment. Finally, the fifth hypothesis (H5) examines the direct effects between task type and recall accuracy of time.

Figure 1. Model of Study



Chapter 4: Methodology

This chapter presents the methodology used for this research project. Section 4.1 details the experimental protocol, including the experimental design, participants, stimulus description, instruments and apparatus, questionnaires and measurements, and the procedure followed during the experiment. Section 4.2, presents the analysis strategy that will be used to interpret the results of this study.

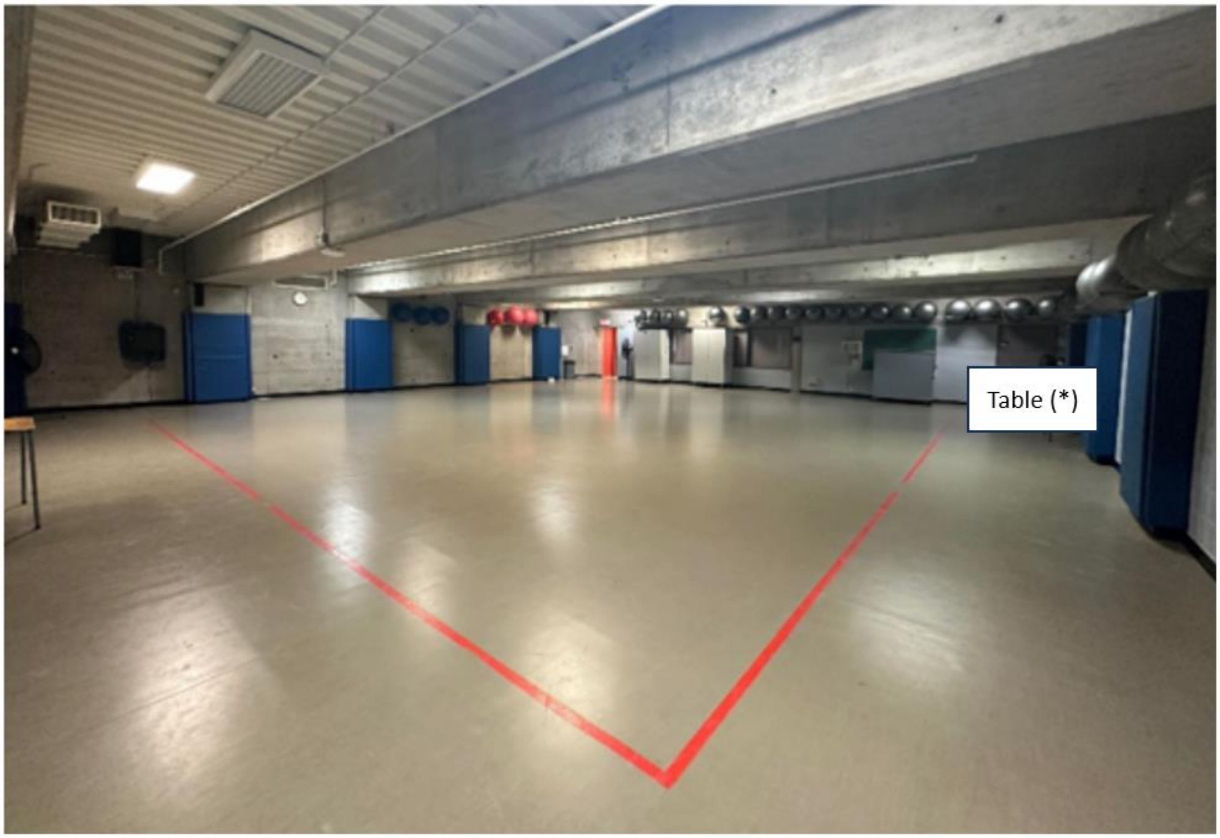
4.1 Experimental Protocol

4.1.1 Experimental Design

The experiment used a between-subject with one factor (type of usage) design. Twenty participants were randomly distributed through each of the four conditions. If participants were assigned to Condition 1 – Texting, participants were instructed to text with their fictional friend Louis and answer the text messages on the Facebook messaging platform in complete sentences while walking. Participants were required to answer a set of predefined open-ended questions, which were sent to them by either the research assistant or the student in charge of the project. In Condition 2 – Reading, participants were instructed to read pre-selected news articles on the LaPresse news application while walking. In Condition 3 – Gaming, participants were instructed to play Tetris while walking. In Condition 4 – Instagram, participants were instructed to watch short-form videos on the social media platform Instagram while walking. Instagram short-form videos, known as "Reels", range from fifteen to ninety seconds and are randomly shown to users through an algorithm that prioritizes content based on users preferences. In each condition, participants did not need to use their personal accounts. A fictional account was created for them and a mobile phone was provided for them. The entire walking task lasted twenty minutes.

Participants had to walk around a gymnasium on a specific route that was defined with a red tape placed on the ground. The route that participants had to walk was 40ft x 40ft. While participants were walking around the room, a research assistant would hold a poster with a letter on it. Each letter was shown for a period of one minute. A total of 16 letters were shown to participants. All participants were exposed to the same sequence of letters for the same amount of time. The setup of the data collection room is depicted in Figure 2.

Figure 2. Picture of Data Collection Room



Note. As shown in the picture, the participant's route was delimited by a red tape placed on the floor of gymnasium. (*) At the table, the research assistant would show the letters (A, B, C, D) to participants.

4.1.2 Participants

Participants were recruited through the institution's pool of participants. Potential participants received an email detailing the experiment and monetary compensation they could receive to participate in the study. When receiving the email, if participants were interested they first had to respond to a screener questionnaire to verify if they could participate in the study. Participants were excluded if they had a physical condition that could prevent them from walking for long periods of time. Participants met the inclusion criteria if they were above 18 years old and were physically capable of walking for long periods of time. After responding to the screener questionnaire, participants could choose their time slot for the experiment. This study was approved by the school's Ethics Research Committee (Certificate #2023-5280).

4.1.3 Stimulus Description

Visual Stimuli. A research assistant was present in the room holding up signs with letters (A, B, C, D) on them. During the walking periods of participants, the assistant would show each letter for a period of one minute. Participants were instructed to try to remember them as they would be questioned about them in the end.

Auditory Stimuli. Sound signals coming from the computer speaker instructed participants when to start and stop walking. When hearing the “Go” sound signal, participants would have to start walking, and when hearing the “Stop” sound signal participants had to stop walking. This procedure was designed to mimic real-life walking scenarios where pedestrians stop before crossing a road, ensuring that the task closely resembles typical pedestrian behavior in such situations.

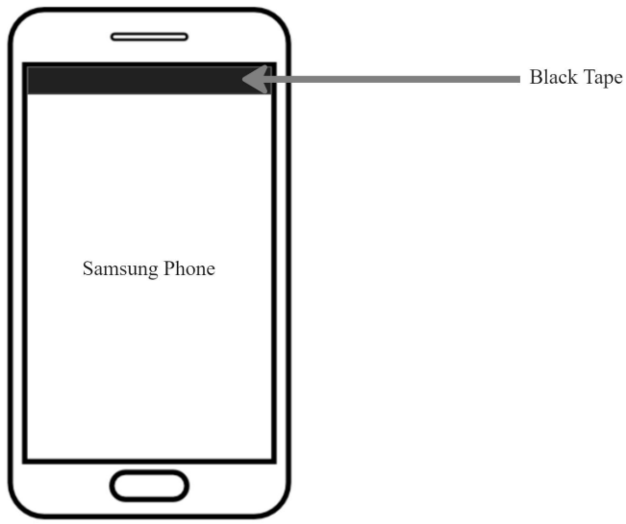
4.1.4 Instruments and Apparatus

Camera. To film the participants' real walking behavior, the Razer Kiyo Pro 1080p HD Webcam (RZ19-03640100-R3U1) was used.

Cobalt Capture. Since this experiment was conducted outside the traditional laboratory setting, specifically in a gymnasium, the research team needed a minimal and adaptable setup. We used a video recording system called Cobalt Capture (Courtemanche, Sénécal, Léger, Fredette, 2022) to record participants’ real-time walking behavior. This system is a software that can be accessible online and connected to any camera linked to a computer.

Smartphone: The mobile phone that participants used during the experiment is a Galaxy A22 Samsung. A black piece of tape was discreetly placed at the top of the smartphone to cover the time display and make participants lose track of time (See Figure 3).

Figure 3. Illustration of Samsung Phone with Black Tape



4.1.5 Questionnaire and Measurements

This section will summarize the list of measurements used throughout the experiment. Below this section, Table 2 will present a summary of all the measurements used in this study.

Participants Demographics: For demographics, participants were asked to answer a questionnaire about their gender, age, and level of education.

Accuracy Recall of Time: To test the participants' recall accuracy of time, participants had to answer a questionnaire right after the experiment where they were asked how much time they thought passed by during the entire task (see Annexe E). Participants had to answer in the number of minutes. The recall accuracy of time was then calculated using the normalized absolute error formula. In this formula, the observed value represents the participant's estimation of time, and the ground truth is the actual time elapsed during the task. Here is the formula:

Normalized absolute error = absolute (observed value - ground truth)/ ground truth.

Accuracy Recall of Environment: At the end of the experiment, participants were asked by questionnaire how many letters they had seen during the task (see Annexe D). Participants could answer with any number from 0 upwards. The recall accuracy of the environment was also calculated using the normalized absolute error formula. The observed value represents the number of letters reported by participants. The ground truth represents the actual number of letters shown to participants during the task. Here is the formula:

Normalized absolute error = absolute (observed value - ground truth)/ ground truth.

Cognitive Absorption Scale: After the task, participants were asked to answer the Cognitive Absorption scale (Agarwal & Karahanna, 2000) to evaluate their level of Cognitive Absorption during the walking task. This scale has five dimensions that measures temporal dissociation, focused attention, heightened enjoyment, control, and curiosity. This scale has 20 items rated on a 7-point Likert scale (1=strongly disagree; 7=strongly agree). The scale was adjusted to the mobile multitasking context (see Annexe C).

Table 2. Summary Table of Measurements

Questionnaire	Description
Pre-experiment Questionnaire (In gymnasium)	
Participant Demographics	Participants were asked about their gender, age and level of education.
Post-experiment Questionnaire (In gymnasium)	
Accuracy Recall of Time	Open response in a number of minutes (see Annexe D).
Accuracy Recall of Environment	Number of different times seen letter A, B, C and D (see Annexe D).
Cognitive Absorption Scale	20 items. 7-point Likert scale (1=Strongly disagree, 7=Strongly agree) (see Annexe C).

4.1.6 Procedure

The experiment was conducted in a gymnasium sports center. Participants were instructed to arrive at the metro station where they were greeted by a research assistant that would direct t
hem to the designated test room. Once they arrived in the room, participants were instructed to leave their personal belongings in a designated area. To make participants lose track of time, they were asked to turn off their phones and remove their watches. Additionally, black tape was discreetly placed on the computer where they had to fill out their questionnaire and on the top of the mobile phone to avoid participants seeing the time (Figure 3). Before starting the experiment, participants were instructed to read and fill out a consent form. Once the form was filled out, participants were asked to fill out a pre-experiment survey on the assistant's computer with a demographic questionnaire. Once the participants completed the questionnaire, a brief description of the task was given to them depending on which condition they were assigned to. Details of the task conditions are presented in Table 3. After the verbal instructions were given to the participant, the participant would have to start the task. The walking task in total lasted twenty minutes. At the end of the task, participants were asked to fill out a post-experiment questionnaire that included accuracy recall of time, accuracy recall of environment and the cognitive absorption questionnaire (Agarwal & Karahanna, 2000). After finishing the questionnaire, the participant was asked to fill out a compensation form and was then accompanied to the metro station. A detailed timeline of the experiment is shown below in Figure 4.

Figure 4. Procedure

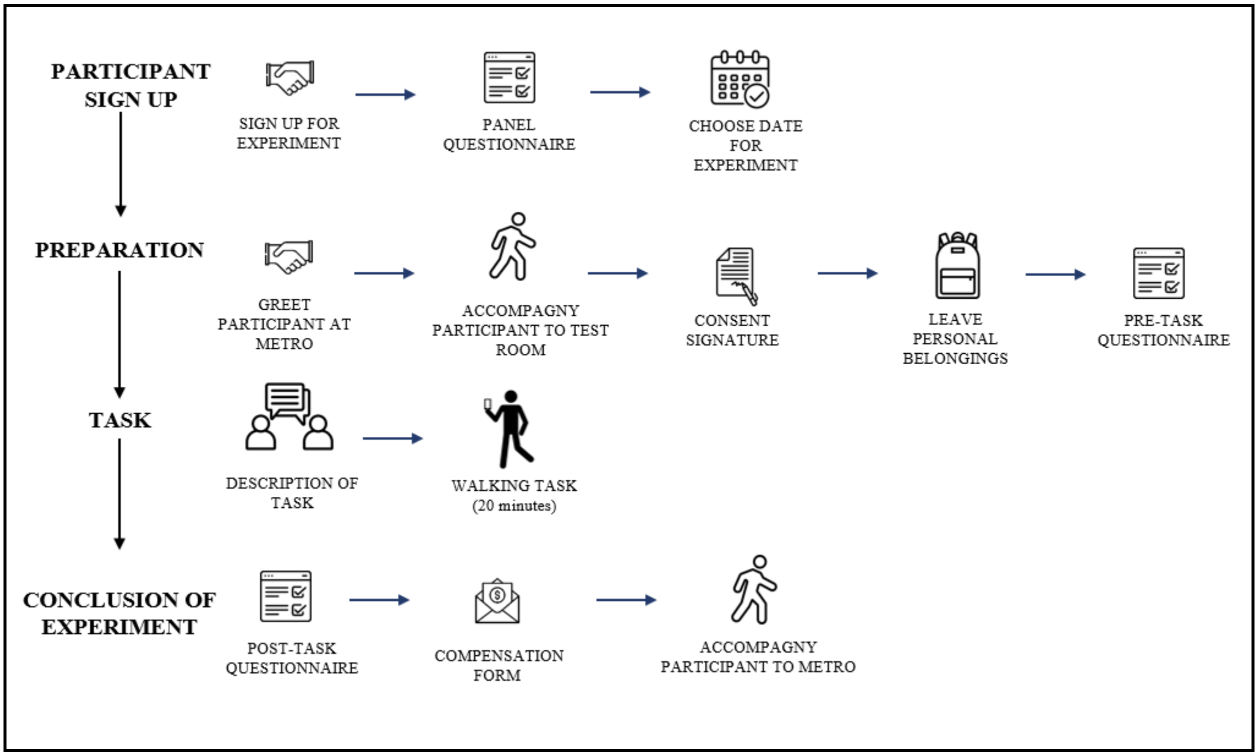


Table 3. Details of the Task Conditions

Conditions	Details
Texting (C1)	Participants were asked to respond to text messages while walking. These text messages were a predefined list of questions sent by the research assistant (see Annexe E).
Reading (C2)	Participants were asked to read a list of news articles while walking.
Gaming (C3)	Participants were asked to play the mobile game “Tetris” while walking. If participants lost in the game, they could restart the same level.
Social Media Videos (C4)	Participants were asked to scroll through short-form videos on a social media platform.

Note. C=Condition.

4.2 Analysis Strategy for Results

For the statistical analyses, the software SAS 9.4 was used. The following analyses were done for each hypothesis.

For H1 a linear regression model was used to estimate the relationship between task type and cognitive absorption. Cognitive absorption was evaluated as a whole and by its individual dimensions. The least square means of the adjusted averages was also compared. To see if there was a significant difference between groups, a two-tailed test was also done. After that, to compare the level of cognitive absorption between each task type, a pairwise comparison test was done. The p-values were adjusted for the multiple comparisons by the method of Holms.

To evaluate H2 we used a linear regression model to investigate the relationship between cognitive absorption and recall accuracy of environment. Cognitive absorption was evaluated as a whole and by dimension. The p-value was adjusted with a 2-tailed test.

Similarly, to evaluate H3 a linear regression model was used to investigate the relationship between cognitive absorption and recall accuracy of time. Cognitive absorption was analysed as a whole and by its individual dimensions. The p-value was adjusted with a 2-tailed test.

For H4, a linear regression model was used to investigate the relationship between task type and recall accuracy of environment. The least-square means of the adjusted averages were compared. A two-tailed test was done to evaluate the significant difference between groups. To evaluate the differences between task type and recall accuracy, a pairwise comparison was done. For this analysis, the p-value was adjusted for multiple comparisons by the method of Holms.

Finally, for H5 a linear regression model was also used to investigate the relationship between task type and recall accuracy of time. The least squares means were compared. A two-tailed test was done to evaluate the significant difference between groups. To evaluate the differences between task type and recall accuracy, a pairwise comparison was done. For this analysis, the p-value was adjusted for multiple comparisons by the method of Holms.

Chapter 5: Analysis and Results

This chapter presents the results obtained from the experiment and analyzes them in relation to the hypotheses. Section 5.1 provides a descriptive analysis of the results. The following section, section 5.2, examines the findings related to the relationship between task type and cognitive absorption. Section 5.3 focuses on the results concerning the relationship between cognitive absorption and recall accuracy of the environment. Finally, section 5.4 presents the findings on the relationship between task type and recall accuracy.

5.1 Descriptive Analysis

5.1.1 Description of Participants

A total of 80 participants were in the study with 38 women and 42 men. The average reported age was 27.66 years old with an age range between 19 and 51 years (mean age: 27.66 years; S.D = 7.07). When reporting their highest level of education, 49% reported having a bachelor's degree, 34% reported having a master's degree, 4% reported having a doctoral degree, 4% reported having a CEGEP degree, 1% reported having a high school degree and 8% reported having another type of degree.

5.1.2 Descriptive Statistics

The descriptive statistics of all variables (see Table 4) show the means and standard deviations of all 80 participants in terms of their cognitive absorption, recall accuracy of time and environment.

When looking at the descriptive statistics of participants' cognitive absorption, the highest mean score was observed in the texting condition (M=4.91, SD=0.562), while the lowest score was found in the reading condition (M=4.63, SD=0.561).

When examining cognitive absorption by dimension, the highest temporal dissociation was reported during the texting condition (M=5.85, SD=0.820), while the lowest was observed during the gaming condition (M=5.21, SD=1.002). For focused immersion, the highest mean score was observed in the gaming condition (M=5.28, SD=0.660) and the lowest in social media (M=4.32, SD=1.201). In terms of heightened enjoyment, participants scored highest in the social media condition (M=5.33, SD=0.974) and the lowest during texting (M=4.79, SD=1.586). In the control dimension, participants scored the highest mean score in the reading condition (M=4.08, SD=0.779) and the lowest score in the lowest score in social media (M=3.72, SD=0.993). Finally, in the curiosity dimension, the highest mean score was recorded in the social media condition (M=4.87, SD=1.531) and the lowest in the gaming condition (M=4.22, SD=1.348).

In terms of recall accuracy of time, the gaming condition has the highest mean error (M=0.28, SD=0.193) and social media the lowest (M=0.25, SD=0.185). For recall accuracy of environment, the gaming condition has the highest mean error (M=0.64, SD=0.420), while the reading condition has the lowest (M=0.30, SD=0.261).

Table 4. Descriptive Statistics

	Texting		**Reading**		**Gaming**		**Social media**	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
CA	4.91	0.562	4.63	0.561	4.72	0.635	4.75	0.762
TD	5.85	0.820	5.42	0.956	5.21	1.002	5.54	0.978
FIM	5.21	1.075	4.45	1.038	5.28	0.660	4.32	1.201
HE	4.79	1.586	4.48	1.192	5.01	1.071	5.33	0.974
CON	4.03	1.086	4.08	0.779	3.90	0.905	3.72	0.993
CU	4.68	1.137	4.73	1.358	4.22	1.348	4.87	1.531
RAT	0.27	0.205	0.27	0.215	0.28	0.193	0.25	0.185
RAE	0.37	0.252	0.30	0.261	0.64	0.420	0.41	0.399

Note. M=Mean, SD=Standard Deviation, CA=Cognitive Absorption, TD=Temporal Dissociation, FIM=Focused Immersion, HE=Heightened Enjoyment, CON=Control, CU=Curiosity, RAT=Recall Accuracy of Time; RAE=Recall Accuracy of Environment.

5.2 Relationship between task type and cognitive absorption (H1)

The first hypothesis is regarding how task types will influence pedestrian's cognitive absorption. More precisely, it was predicted that gaming or texting will exhibit higher levels of cognitive absorption (H1a). Additionally, it was predicted that reading or social media will exhibit lower levels of cognitive absorption (H1b). Pedestrian multitasking with social media were predicted to have a relationship with cognitive absorption (H1c). Cognitive absorption was initially evaluated as whole and then assessed by its individual dimensions (see Table 5).

First, an evaluation of the effect of task type on cognitive absorption was conducted. It was found that the type of task did not have a significant effect on pedestrians' levels of cognitive absorption ($F=0.68$, $p= 0.5692$, $DF=76$). However, when examining the individual dimensions of cognitive absorption, a significant effect emerged in one particular dimension. Task type was significantly associated with the Focused Immersion (FIM) dimensions of the cognitive absorption scale ($F=4.87$, $p=0.0038$, $DF=76$). The other dimensions such as TD ($F=1.61$, $p= 0.1934$, $DF=76$), HE ($F=1.71$, $p= 0.1722$, $DF=76$), CON ($F=0.6$, $p= 0.6183$, $DF=76$), CU ($F=0.88$, $p= 0.4562$, $DF=76$) were not statistically significant. Since FIM seems to vary by task type, a pairwise comparison (see Table 6) was conducted to identify which task types differ from each other.

According to the pairwise comparison results (see Table 6), FIM seems significantly higher for participants in the texting condition than for the social media condition ($t=2.78$, $p=0.0346$, $DF=76$). FIM seems significantly lower for participants in the reading condition than the gaming condition. ($t= -2.59$, $p=0.0461$, $DF=76$). FIM seems significantly higher for the gaming condition than for the social media condition ($t=2.99$, $p=0.0222$, $DF=76$). At the 10% significance level, FIM seems higher for the texting condition than for the reading condition ($t=2.37$, $p=0.0608$, $DF=76$). Comparisons of Texting vs. Gaming ($t= -0.22$, $p=1.000$, $DF=76$) and Reading vs. Social media ($t=0.41$, $p=1.000$, $DF=76$) were not statistically significant.

Thus, there is no effect of task type on overall cognitive absorption, but there is an effect on one of its dimensions, namely FIM. Considering the significant effects of task type on the FIM, it can be concluded that H1a is partially supported, as pedestrians multitasking with gaming or texting exhibit higher levels of FIM. H1b is also partially supported as pedestrians multitasking with reading or social media exhibit lower levels of FIM. H1c is partially supported, as pedestrians multitasking with social media experience significant levels of FIM when compared to texting or gaming, however to a lower extent.

Table 5. Results for H1

	CA	FIM	TD	HE	CU	CON
Task Type	0.5692	0.0038*	0.1934	0.1722	0.4562	0.6183

Note. + p < 0.10; *p < 0.05; CA=Cognitive Absorption; FIM=Focused Immersion; TD=Temporal Dissociation; HE=Heightened Enjoyment; CU=Curiosity; CON=Control.

Table 6. Pairwise comparison results of Focused Immersion for H1

	T vs. R	T vs. G	T vs. S	R vs. G	R vs. S	G vs. S
FIM	0.0608^{+}	1.0000	0.0346*	0.0461*	1.0000	0.0222*

Note. + p < 0.10; *p < 0.05; FIM=Focused Immersion; T=Texting; R=Reading; G=Gaming; S=social media.

5.3 Relationship between cognitive absorption and recall accuracy of environment (H2)

The second hypothesis concerns the effects of cognitive absorption on pedestrian's recall accuracy of their environment. It was predicted that individuals with higher cognitive absorption would exhibit lower recall accuracy of their environment. Cognitive absorption was first evaluated as a whole, and it was also assessed based on its individual dimensions (see Table 7).

At the 10% significance level, cognitive absorption demonstrated an effect on participants' recall accuracy of their environment (t=1.83, p= 0,071, DF=76). Participants that reported higher scores of cognitive absorption, were significantly associated with higher errors in recalling letters, consequently leading to lower accuracy in recalling their environment. When examining cognitive absorption by its dimensions, the dimension Heightened Enjoyment (HE) showed a significant association with participants' recall accuracy of their environment (t=2.98, p=0,0038, DF=78). Participants who reported high levels of HE were significantly associated with higher errors in recalling letters, resulting in lower accuracy in recalling their environment. Other dimensions such as FIM (t=1.23, p=0,2242, DF=78), TD (t=-0.6, p=0,5471, DF=78), CU (t=1.06, p=0,2912, DF=78) and CON (t=-0.04, p=0.968, DF=78) were not significantly associated with participants' recall accuracy of environment.

Thus, there is an effect on cognitive absorption as a whole, though it is observed at the 10% significance level. Additionally, there is also an effect on one of its dimensions, notably HE. Therefore, it can be concluded that H2 is supported as individuals with higher cognitive absorption or HE exhibit lower recall accuracy of their environment.

Table 7. Results for H2

	CA	**FIM**	**TD**	**HE**	**CU**	**CON**
Recall Accuracy of Environment	0.0710^{+}	0.2242	0.5471	0.0038*	0.2912	0.968

Note. + p < 0.10; *p < 0.05; CA=Cognitive Absorption; FIM=Focused Immersion; TD=Temporal Dissociation; HE=Heightened Enjoyment; CU=Curiosity; CON=Control.

5.5 Relationship between cognitive absorption and recall accuracy of time (H3)

The third hypothesis concerns the relationship between cognitive absorption and individuals' perception of time. It was hypothesized that individuals experiencing higher levels of cognitive absorption would exhibit lower accuracy in recalling time. A first evaluation of cognitive absorption was done, followed by an analysis of its individual dimensions (see Table 8).

At the 10% significance level, cognitive absorption exhibits a significant effect on the recall accuracy of time (t=-1.94, p=0.0565, DF=78). Participants that scored higher levels of cognitive absorption led to lower errors in time. When looking at cognitive absorption by its individual dimensions, only one particular dimension had significant effects. HE had a significant effect on recall accuracy of time (t=-2.38, p=0.0198, DF=78). Higher HE was significantly related to lower errors in times. The other dimensions such as FIM (t=0.26, p=0.7939, DF=78), TD (t=-0.27, p=0.7869, DF=78), CU (t=-1.21, p=0.2312, DF=78) and CON (t=-1.49, p=0.1392, DF=78) were not significantly associated with participants' recall accuracy of time.

In summary, higher levels of cognitive absorption, and its individual component HE, led to lower accuracy in recalling time. Therefore, it can be concluded that H3 is supported.

Table 8. Results for H3

	CA	**FIM**	**TD**	**HE**	**CU**	**CON**
Recall Accuracy of Time	0.0565^{+}	0.7939	0.7869	0.0198*	0.2312	0.1392

Note. + p < 0.10; *p < 0.05; CA=Cognitive Absorption; FIM=Focused Immersion; TD=Temporal Dissociation; HE=Heightened Enjoyment; CU=Curiosity; CON=Control.

5.4 Relationship between task type and recall accuracy (H4 & H5)

5.4.1 Direct Effects of Task Type on Recall Accuracy of Environment (H4)

The fourth hypothesis evaluated if certain task types had a direct effect on participants' recall accuracy of their environment. Task type did have an effect on participant's recall accuracy of their environment (F=3.78, p=0.0139, DF=76) (see Table 9). To be able to understand these effects a pairwise comparison was conducted to specify which tasks had significant effects (see Table 10). Participants in the reading condition reported less errors in their environment than for participants in the gaming condition (t= -3.18, p=0.0128, DF=76). Therefore, participants in the reading conditions experienced higher recall accuracy than in the gaming condition. At the 10% significance level, participants in the texting condition reported lower errors in their environment than for participants in the gaming condition (t= -2.5, p=0.0729, DF=76). Therefore, participants in the texting condition experienced higher recall accuracy of the environment than participants in the gaming condition.

Thus, it can be concluded that H4 is supported as the task type does have an effect on participants' recall accuracy of their environment. More precisely, participants in the reading condition demonstrated significantly higher recall accuracy of their environment, while those in the gaming condition showed significantly lower recall accuracy of their environment. Some significance was also observed between texting and gaming, however this was at the 10% significance level. Participants in the texting condition experienced higher recall accuracy of their environment than the gaming condition.

Table 9. Results for H4 and H5

	Recall Accuracy of Environment	**Recall Accuracy of Time**
Task Type	0.0139*	0.9682

Note. *p < 0.05.

Table 10. Pairwise comparison results for H4

	T vs. R	**T vs. G**	**T vs. S**	**R vs. G**	**R vs. S**	**G vs. S**
RAE	0.9977	0.0729^{+}	0.9977	0.0128*	0.9472	0.1326

Note. + p < 0.10; *p < 0.05; RAE= Recall Accuracy of Environment; T represents texting; R represents reading; G represents gaming; S represents social media.

5.4.2 Direct Effects of Task Type on Recall Accuracy of Time (H5)

The fifth hypothesis is regarding the relationship between task type and recall accuracy of time. More precisely, if there is a direct effect between the two. Results concluded that task type did not have an effect on participants' recall accuracy of time (F=0.08, p=0.9682, DF=76) (see Table 9). Therefore, H5 is not supported concluding that there is no direct relationship between task type and recall accuracy of time.

Table 11. Summary Table of All Results

		Task Type					
H1	**CA**	0.5692					
	FIM	0.0038*					
	TD	0.1934					
	HE	0.1722					
	CU	0.4562					
	CON	0.6183					
		CA	**FIM**	**TD**	**HE**	**CU**	**CON**
H2	**RAE**	0.0710+	0.2242	0.5471	0.0038*	0.2912	0.968
H3	**RAT**	0.0565+	0.7939	0.7869	0.0198*	0.2312	0.1392
		Task Type					
H4	**RAE**	0.0139*					
H5	**RAT**	0.9682					

Note. + p < 0.10; *p < 0.05; CA=Cognitive Absorption; FIM=Focused Immersion; TD=Temporal Dissociation; HE=Heightened Enjoyment; CU=Curiosity; CON=Control; RAE=Recall Accuracy of Environment; RAT=Recall Accuracy of Time;

Chapter 6: Discussion

The purpose of this study was to further explore the effects of task types on pedestrians' accuracy of recall, with a particular focus on short-formed videos, a task type that has received limited attention in the literature. Additionally, this study aimed to expand the research on the mediating effects of cognitive absorption in pedestrian mobile multitasking activities.

The first objective of this study was to examine the direct effect of how task type influences accuracy of recall of pedestrians engaged in mobile multitasking activities. It was found that task type did have a direct effect on participants' recall accuracy of their environment. Specifically, participants engaging in the reading task reported fewer errors in correctly identifying letters shown to them in their environment compared to participants in the gaming task. Participants in the texting task also reported less errors in their environment than participants in the gaming task, though this was observed at the 10% significance level. However, task type did not have a direct effect on recall accuracy of time among pedestrians.

These findings suggest that the type of task used on pedestrians' mobile plays a crucial role in their ability to recall environmental details. Participants reading or texting on their phones may facilitate greater attention to environmental details compared to gaming tasks, which might demand more divided attention or cognitive resources. This finding aligns with previous research suggesting that gaming activities while walking may pose greater risks than other task types (Labonte-LeMoyne et al., 2022). Interestingly, short-form videos had no direct effect on pedestrians recall accuracy. Further research on this task type should investigate whether it has other types of effects on pedestrians. The lack of significant findings in recall accuracy of time could indicate that task type might not impact pedestrians' ability to recall time.

The second objective of this study was to investigate how cognitive absorption mediates the relationship between task type and pedestrians' recall accuracy of their environment and time during mobile multitasking. It was found that there is no significant effect of task type on overall cognitive absorption. However, task type did show a significant effect on one of its individual dimensions known as focused immersion. Individuals in the gaming and texting tasks experienced higher levels of focused immersion, whereas those in the reading and social media tasks experienced lower levels. This finding aligns with previous studies, indicating that texting and gaming are more dangerous for pedestrians (Labonte-LeMoyne et al., 2022; Pourchon et al., 2017). Interestingly, short-form videos also influenced individual levels of focused immersion, underscoring the relevance of exploring these effects further.

In terms of the relationship of cognitive absorption and recall accuracy of the environment, it was found that individuals experiencing higher levels of cognitive absorption exhibited lower recall accuracy of their environment. This suggests that participants that were highly immersed, were less capable of remembering elements present in their environment. Additionally, participants experiencing higher levels of heightened enjoyment, a sub-dimension of cognitive absorption, were less able to accurately recall elements in their environment. Similarly, individuals exhibiting higher levels of cognitive absorption and heightened enjoyment experienced lower recall accuracy of time.

Cognitive absorption did not completely mediate the relationship between task type and recall accuracy, but some interesting relationships with sub-dimensions did emerge. Task type influences pedestrians' levels of cognitive absorption, but primarily through the individual dimension of focused immersion. Cognitive absorption as a whole did influence pedestrians recall accuracy and also within one of its dimensions of heightened enjoyment. The unexpected finding that cognitive absorption sometimes impacts recall accuracy not as a whole scale but through its individual dimensions suggests that the scale may need further refinement and understanding in the context of mobile multitasking while walking. Additionally, short-form videos had no direct effect on recall accuracy, but they did affect it indirectly through cognitive absorption. This highlights the need for further research on social media short-form videos to explore these discrepancies.

A first point worth discussing is that the cognitive absorption scale is sometimes significant through its sub-dimensions or as a whole. Cognitive absorption is frequently used in research, but some studies have reported conflicting findings regarding its relationship with other constructs (Oz et al., 2024). Many other studies have also faced a similar conclusion that this construct as a whole is often not predictive and only certain parts if the dimension were involved in the explanation of the phenomenon. For example, a study conducted by Léger et al. (2014), found that the dimensions of control and focused immersion were more strongly influenced by neurophysiological markers, indicating that these dimensions had a greater impact compared to the rest of the cognitive absorption dimensions. A recent meta-analysis (Oz et al., 2024) on the cognitive absorption scale found that the temporal dissociation and the control dimensions have weaker correlations compared to its other dimensions. This finding aligns with our study, as these dimensions were not significantly relevant in our context. Our study found that the dimensions focused immersion and heightened enjoyment were statistically significant. In the context of this study, focused immersion could have been more predictive because participants were deeply engaged in their mobile task, making it harder for them to answer to other attentional demands such as noticing elements in their environment. Heightened enjoyment is also likely to be a strong predictor because of participants' emotional engagement while interacting with their mobile phone. As participants experienced positive emotions while interacting with their phones, they were less likely to recall elements in their environment and lost the passage of time.

An additional important consideration for the cognitive absorption scale is that it is a self-perceived measure. The cognitive absorption scale requires participants to complete the scale after a certain task, therefore potentially introducing certain biases and inaccuracies. This scale is trying to capture a phenomenon that is by nature automatic and unconscious. There is a growing body of research attempting to use neuroscientific and psychophysiological measures to capture this cognitive state unobtrusively. For example, a study investigating the intrinsic motivations in learning has used the cognitive absorption scale while simultaneously using tools such as EEG, EDA and HRV to fully capture participants' levels of absorption (Léger et al., 2014). Further research should use neuroscientific and psychophysiological measures instead of the cognitive absorption scale to fully capture an individuals' state.

Another aspect to discuss is regarding the use of recall accuracy as a dependent variable in this study. There might be certain limitations to using recall accuracy that may challenge its effectiveness in fully capturing the impact of mobile multitasking. In terms of recall accuracy of the environment, when walking participants not remembering what they have seen in their surroundings could suggest some form of inattentional blindness but may not be dangerous to pedestrians. While recall accuracy was important to understand how various task types affect pedestrians and how cognitive absorption mediates this relationship,it might not capture the entire phenomenon. Future studies should consider additional outcomes. For example, observing participant's behavior directly could show when participants engage in illegal behaviors or fail to notice dangers. These observational measures could complement recall accuracy of the environment and gain better understanding of the impacts of mobile multitasking on pedestrian safety.

A final aspect to address is the task type of short-formed social media videos and how it compares to other task types that have been widely studied in the literature. As expected, texting and gaming were tasks that had the most significant effects on participants compared to the reading and social media task. However, the lower effect of social media videos could benefit from further exploration, as certain testing conditions may have not fully captured the effects on pedestrians. One potential reason for the weaker effect of social media videos is that the videos used were not personalized for participants. As participants were given a smartphone with an account set up for them, the application's algorithm didn't have time to generate a personalized feed of videos. Personalized content could have a stronger impact, as users typically engage more deeply with content personalized for their interests and preferences. Future research should consider using participant's personal social media accounts to have a more accurate representation of how personalized content affects pedestrians. Additionally, exploring different types of social media content could be interesting for future research. For example, funny videos, news videos, instructional videos, or content from friends versus famous people. Also, exploring how different lengths of Instagram can impact pedestrians would be valuable, as these can range from 15 seconds to 90 seconds. By investigating these alternative conditions, this could help the scientific community gain a better understanding of how short-form social media videos can impact a pedestrian.

Chapter 7: Conclusion

In this chapter, the concluding remarks of this thesis will be presented. Section 7.1 provides a brief overview of the results obtained in this study. Section 7.2 highlights the contributions that this study has made to the scientific community. Section 7.3 addresses the limitations of the study. Finally, section 5.4 offers suggestions for future research and concludes with final comments.

7.1 Review of Results

This study helped identify that cognitive absorption did not completely mediate the relationship between task type and recall accuracy of environment or time. First, the relationship between task type and cognitive absorption, showed significant effects on its' individual dimension of focused immersion, not on cognitive absorption in its entirety. With gaming and texting having higher levels of focused immersion, compared to tasks like reading and social media. This study also wanted to investigate the effects of social media short-form videos, and significant effects were observed on pedestrians' levels of focused immersion.

Furthermore, cognitive absorption significantly affected recall accuracy of the environment, although at the 10% significance level. Also the sub-dimension of cognitive absorption, heightened enjoyment, showed significant effects on recall accuracy of the environment. Participants experiencing higher levels of cognitive absorption or heightened enjoyment were less capable of accurately recalling elements in their environment. Similarly, cognitive absorption had a significant effect at the 10% level on participants recall accuracy of time. Additionally, the sub-dimension of heightened enjoyment had a significant effect on participants' recall accuracy of time. Participants with higher levels of cognitive absorption or heightened enjoyment had a significant effect on recall accuracy of time. Therefore, as a mediator, cognitive absorption showed effects, sometimes observed through its sub-dimensions and other times in its entirety.

When looking at the direct effect of task type on pedestrian's recall accuracy of environment and time, it was found that task type does have a direct effect on participants' recall accuracy of their environment, but no direct effect between task type and recall accuracy of time. Gaming was identified as the most difficult task for participants to accurately recall elements in their environment.

7.2 Contributions

This study makes several contributions to the literature on mobile multitasking while walking. First, this study further explored the effects of task types on pedestrians. This study confirmed previous studies stating that gaming and texting while walking pose higher risks to pedestrians. In addition, this study is one of the very limited studies that has investigated the use of watching short-form social media videos while walking. In this regard, it was found that these types of videos do have some effect on pedestrians providing the scientific community a new task type to explore.

A significant methodological contribution of this study is the setting in which the research was conducted. While the majority of studies are typically performed on a treadmill in a controlled lab environment (Chopra et al., 2018; Hinton et al., 2018; Kim et al., 2022; Labonte-LeMoyne et al., 2022; Mourra et al., 2020), this study took on the challenge of being conducted in a gymnasium. Although some studies have explored mobile multitasking in more realistic settings (Pourchon et al., 2017), this study contributes to this growing body of work examining participants in a more natural environment. Conducting the experiment in a gymnasium allowed participants to walk and navigate through a room while engaging in a mobile task, which created a more naturalistic environment compared to treadmill based studies commonly used in the literature.

Another contribution to the literature, this present study also helps extend the research on cognitive absorption when pedestrians are engaged in mobile multitasking activities. This study helped discover that cognitive absorption may not be a strong mediator to explain the relationship between the type of task present on a pedestrians' phone and their recall accuracy of environment and time. Additionally, this study contributes to the literature by demonstrating that the cognitive absorption scale has certain dimensions more significant than others as demonstrated by previous studies (Léger et al., 2014; Oz et al., 2024).

From a practical perspective, the results of this study provide insights into the possibility of cognitive absorption as a strategy for policy-makers and designers to diminish pedestrians' mobile multitasking behaviors. Although cognitive absorption was found to not be a strong mediator between pedestrian's type of task on their mobile and their ability to recall elements in their environment or the passage of time, further research is needed to explore these effects. Future studies could also investigate other methods of measuring absorption and develop effective strategies to diminish mobile multitasking while walking.

7.3 Limitations

Certain limitations need to be considered. First, this study had no physiological tools therefore we couldn’t capture the entire behavior of participants. Additionally, the environmental conditions of the experiment placed participants in a setting with non-natural obstacles such as trees, benches, roads to cross, pedestrians to avoid, potentially making the test less challenging than a real-world scenario. Cognitive absorption was measured with a self-reported questionnaire which may be subject to bias as participants completed the questionnaire after the task. As a result, the questionnaire may not have accurately captured the actual cognitive state of participants during the task.

7.4 Future Research

This study highlighted several points that can guide future research on mobile multitasking while walking. First, future research should be conducted in a more realistic outdoor setting. Future studies could have participants navigate through the city where natural obstacles are present, such as trees, benches, roads to cross, pedestrians to avoid.

Future research should explore more in depth the use of short-form videos while walking and compare their effects to other task types. Since this task type has barely been studied, examining it would help to fully understand its various effects on pedestrians. Future research should consider using participants' own social media accounts to ensure that they engage with their own personal content, providing a more accurate representation of their natural behavior while walking. Another research possibility could involve comparing the effect of different types of content such as funny videos, news videos, instructional videos, content from friends versus famous people etc… Researchers could also consider investigating the various functionalities of social media platforms such as watching videos, looking at pictures, commenting, messaging etc… Furthermore, studying the effects of video lengths on pedestrians could also be interesting.

Future studies should also consider alternative methods of measuring absorption such as using neuroscientific and psychophysiological measures. These approaches could capture this cognitive state in real-time and unobtrusively, complementing the cognitive absorption scale and providing a more accurate representation of pedestrians' levels of absorption. Finally, future research should explore other potential mediators and their effects on outcomes like environmental recall accuracy and time perception. Identifying these mediators could provide a deeper understanding of the underlying mechanisms causing the effects observed in pedestrian mobile multitasking activities.

In conclusion, this study has provided valuable insights into the effects of certain task types on pedestrians and how cognitive absorption can influence their behavior. As mobile multitasking continues to lead to increased pedestrian accidents, there is an urgent need for further research on the underlying mechanisms of this behavior. Understanding these mechanisms more deeply will allow policy-makers and designers to develop targeted interventions to improve pedestrian safety.

Bibliography

20+ Interesting Short Form Video Statistics & Trends (2024). (2024, February 29). https://vidico.com/news/short-form-video-statistics/

57+ Incredible Smartphone Addiction Statistics for 2023. (2022, July 26). Exploding Topics. https://explodingtopics.com/blog/smartphone-addiction-stats

Agarwal, R., & Karahanna, E. (2000). Time Flies When You're Having Fun: Cognitive Absorption and Beliefs about Information Technology Usage. *MIS Quarterly*, *24*(4), 665–694. https://doi.org/10.2307/3250951

Agostini, V., Lo Fermo, F., Massazza, G., & Knaflitz, M. (2015). Does texting while walking really affect gait in young adults? *Journal of NeuroEngineering and Rehabilitation*, *12*(1), 86. https://doi.org/10.1186/s12984-015-0079-4

Almajid, R., Appiah-Kubi, K. O. O., Cipriani, D., & Goel, R. (2023). Dual-tasking interference is exacerbated outdoors: A pilot study. *FRONTIERS IN SPORTS AND ACTIVE LIVING*, *5*. https://doi.org/10.3389/fspor.2023.1077362

André, F., Broman, N., Håkansson, A., & Claesdotter-Knutsson, E. (2020). Gaming addiction, problematic gaming and engaged gaming – Prevalence and associated characteristics. *Addictive Behaviors Reports*, *12*, 100324. https://doi.org/10.1016/j.abrep.2020.100324

APA. (2006). *Multitasking: Switching costs*. Https://Www.Apa.Org. https://www.apa.org/topics/research/multitasking

Appelbaum, S. H., Marchionni, A., & Fernandez, A. (2008). The multi-tasking paradox: Perceptions, problems and strategies. *Management Decision*, *46*(9), 1313–1325. https://doi.org/10.1108/00251740810911966

Barin, E. N., McLaughlin, C. M., Farag, M. W., Jensen, A. R., Upperman, J. S., & Arbogast, H. (2018). Heads Up, Phones Down: A Pedestrian Safety Intervention on Distracted Crosswalk Behavior. *Journal of Community Health*, *43*(4), 810–815. https://doi.org/10.1007/s10900-018-0488-y

Birk, M. V., Mandryk, R. L., & Atkins, C. (2016). The motivational push of games: The interplay of intrinsic motivation and external rewards in games for training. *Proceedings of the 2016 Annual Symposium on Computer-Human Interaction in Play*, 291–303.

Bovonsunthonchai, S., Ariyaudomkit, R., Susilo, T. E., Sangiamwong, P., Puchaphan, P., Chandee, S., & Richards, J. (2020). The impact of different mobile phone tasks on gait behaviour in healthy young adults. *Journal of Transport and Health*, *19*, 100920. https://doi.org/10.1016/j.jth.2020.100920

Boyle, E. A., Connolly, T. M., Hainey, T., & Boyle, J. M. (2012). Engagement in digital entertainment games: A systematic review. *Computers in Human Behavior*, *28*(3), 771–780. https://doi.org/10.1016/j.chb.2011.11.020

Cameron, A.-F., & Webster, J. (2011). Relational Outcomes of Multicommunicating: Integrating Incivility and Social Exchange Perspectives. *Organization Science*, *22*(3), 754–771. https://doi.org/10.1287/orsc.1100.0540

Carrier, L. M., Rosen, L. D., Cheever, N. A., & Lim, A. F. (2015). Causes, effects, and practicalities of everyday multitasking. *Developmental Review*, *35*, 64–78. https://doi.org/10.1016/j.dr.2014.12.005

Chen, P. L., & Pai, C. W. (2018a). Pedestrian smartphone overuse and inattentional blindness: An observational study in Taipei, Taiwan. *BMC Public Health*, *18*(1), 1–10. https://doi.org/10.1186/s12889-018-6163-5

Chen, P. L., & Pai, C. W. (2018b). Smartphone gaming is associated with pedestrians' head-turning performances: An observational study of street-crossing behaviors at uncontrolled intersection in Taipei. *International Journal of Sustainable Transportation*, *12*(1), 12–18. https://doi.org/10.1080/15568318.2017.1321706

Chen, P.-L., & Pai, C.-W. (2018). Evaluating the effects of smartphone racing games and other game types on pedestrian's risk-taking inclinations. *COMPUTERS IN HUMAN BEHAVIOR*, *88*, 78–83. https://doi.org/10.1016/j.chb.2018.06.022

Chen, Q., & Yan, Z. (2016). Does multitasking with mobile phones affect learning? A review. *Computers in Human Behavior*, *54*, 34–42. https://doi.org/10.1016/j.chb.2015.07.047

Chen, S.-H., Lo, O.-Y., Kay, T., & Chou, L.-S. (2018). Concurrent phone texting alters crossing behavior and induces gait imbalance during obstacle crossing. *GAIT & POSTURE*, *62*, 422–425. https://doi.org/10.1016/j.gaitpost.2018.04.004

Chopra, P., Castelli, D. M., & Dingwell, J. B. (2018). Cognitively Demanding Object Negotiation While Walking and Texting. *Scientific Reports*, *8*(1), 1–13. https://doi.org/10.1038/s41598-018-36230-5

Courtemanche, F., Labonté-LeMoyne, E., Léger, P.-M., Fredette, M., Senecal, S., Cameron, A.-F., Faubert, J., & Bellavance, F. (2019). Texting while walking: An expensive switch cost. *Accident Analysis & Prevention*, *127*, 1–8. https://doi.org/10.1016/j.aap.2019.02.022

Dam, A., Oberoi, P., Pierson, J., Jeon, M., & Patrick, R. N. C. (2023). Technological and social distractions at unsignalized and signalized campus crosswalks: A multi-stage naturalistic observation study. *TRANSPORTATION RESEARCH PART F-TRAFFIC PSYCHOLOGY AND BEHAVIOUR*, *97*, 246–267. https://doi.org/10.1016/j.trf.2023.07.003

Davis, S. J., & Barton, B. K. (2017). Effects of secondary tasks on auditory detection and crossing thresholds in relation to approaching vehicle noises. *ACCIDENT ANALYSIS AND PREVENTION*, *98*, 287–294. https://doi.org/10.1016/j.aap.2016.10.024

Davis, S. J., Barton, B. K., Pugliese, B. J., & Lopez, G. (2021). The influences of listening and speaking on pedestrians' assessments of approaching vehicles. *TRANSPORTATION RESEARCH PART F-TRAFFIC PSYCHOLOGY AND BEHAVIOUR*, *82*, 348–358. https://doi.org/10.1016/j.trf.2021.09.002

eMarketer. (2022, June 9). *Time spent with nonvoice activities on mobile phones every day in the United States from 2019 to 2024 (in minutes) [Graph]*. In Statista. https://www.statista.com/statistics/1045353/mobile-device-daily-usage-time-in-the-us/

Ferraro, F. R., Holte, A. J., & Giesen, D. (2022). Does texting make you slower? *CURRENT PSYCHOLOGY*, *41*(5), 2980–2984. https://doi.org/10.1007/s12144-020-00821-1

GHSA. (2023). *Pedestrian Traffic Fatalities by State: 2022 Preliminary Data | GHSA*. https://www.ghsa.org/resources/Pedestrians23

Gruden, C., Istoka Otkovic, I., & Sraml, M. (2022). An Eye-Tracking Study on the Effect of Different Signalized Intersection Typologies on Pedestrian Performance. *SUSTAINABILITY*, *14*(4). https://doi.org/10.3390/su14042112

Haga, S., Fukuzawa, K., Kido, E., Sudo, Y., & Yoshida, A. (2016). Effects on Auditory Attention and Walking While Texting with a Smartphone and Walking on Stairs. In C. Stephanidis (Ed.), *HCI INTERNATIONAL 2016—POSTERS' EXTENDED ABSTRACTS, PT I* (Vol. 617, pp. 186–191). https://doi.org/10.1007/978-3-319-40548-3_31

Hasan, R., & Hasan, R. (2022). Pedestrian safety using the Internet of Things and sensors: Issues, challenges, and open problems. *Future Generation Computer Systems*, *134*, 187–

203. https://doi.org/10.1016/j.future.2022.03.036

Hinton, D. C., Cheng, Y.-Y., & Paquette, C. (2018). Everyday multitasking habits: University students seamlessly text and walk on a split-belt treadmill. *GAIT & POSTURE*, *59*, 168–173. https://doi.org/10.1016/j.gaitpost.2017.10.011

Hossain, M. M., Zhou, H., Sun, X., Hossain, A., & Das, S. (2024). Crashes involving distracted pedestrians: Identifying risk factors and their relationships to pedestrian severity levels and distraction modes. *Accident Analysis & Prevention*, *194*, 107359. https://doi.org/10.1016/j.aap.2023.107359

Hyman, I. E., Boss, S. M., Wise, B. M., McKenzie, K. E., & Caggiano, J. M. (2010). Did you see the unicycling clown? Inattentional blindness while walking and talking on a cell phone. *Applied Cognitive Psychology*, *24*(5), 597–607. https://doi.org/10.1002/acp.1638

illumy, T. (2023, April 14). *What Happened to Blackberry? The History of the Blackberry Phone*. Illumy. https://www.illumy.com/blackberry-phone/

Jones, M. (2014, September 14). *iPhone History: Every Generation in Timeline Order 2007 – 2023 | History Cooperative*. https://historycooperative.org/the-history-of-the-iphone/

Kim, E., Kim, H., Kwon, Y., Choi, S., & Shin, G. (2021). Performance of ground-level signal detection when using a phone while walking. *Accident Analysis & Prevention*, *151*(November 2020), 105909. https://doi.org/10.1016/j.aap.2020.105909

Kim, E., Kwon, Y., Kim, H., & Shin, G. (2022). The range of visual detection of ground-level cues during distracted walking: Effect of cue contrast and walking speed. *ACCIDENT ANALYSIS AND PREVENTION*, *176*. https://doi.org/10.1016/j.aap.2022.106800

Labonte-LeMoyne, E., Cameron, A.-F., Sénécal, S., Fredette, M., Faubert, J., Lepore, F., & Léger, P.-M. (2022). What's that on Your Phone? Effects of Mobile Device Task Type on Pedestrian Performance. *Human Factors*, 00187208221141175. https://doi.org/10.1177/00187208221141175

Larche, C. J., Musielak, N., & Dixon, M. J. (2017). The Candy Crush Sweet Tooth: How 'Near-misses' in Candy Crush Increase Frustration, and the Urge to Continue Gameplay. *Journal of Gambling Studies*, *33*(2), 599–615. https://doi.org/10.1007/s10899-016-9633-7

Léger, P.-M., Davis, F. D., Cronan, T. P., & Perret, J. (2014). Neurophysiological correlates of cognitive absorption in an enactive training context. *Computers in Human Behavior*, *34*, 273–283. https://doi.org/10.1016/j.chb.2014.02.011

Li, H., & Ming, X. (2016). *Study on the Effect of Distraction for Pedestrian Crossing*. *Iceep*, 878–881. https://doi.org/10.2991/iceep-16.2016.153

Lim, J., Lee, S., Choi, J., & Joo, S. (2016). The Comparative Study on Travel Behavior and Traffic Accident Characteristics on a Community Road—With Focus on Seoul Metropolitan City. *KSCE Journal of Civil and Environmental Engineering Research*, *36*(1), 97–104. https://doi.org/10.12652/Ksce.2016.36.1.0097

Lin, M. I. B., & Huang, Y. P. (2017). The impact of walking while using a smartphone on pedestrians' awareness of roadside events. *Accident Analysis and Prevention*, *101*, 87–96. https://doi.org/10.1016/j.aap.2017.02.005

Luo, Y., Grimaldi, N., Zheng, H., Giang, W. C. W., & Hu, B. (2023). Distraction From Smartphones Changed Pedestrians? Walking Behaviors in Open Areas. *MOTOR CONTROL*, *27*(2), 275–292. https://doi.org/10.1123/mc.2022-0023

Mack, A. (2003). Inattentional Blindness: Looking Without Seeing. *Current Directions in Psychological Science*, *12*(5), 180–184. https://doi.org/10.1111/1467-8721.01256

Mack, A., & Rock, I. (1998). Inattentional blindness: Perception without attention. *Visual Attention*, *8*(01).

Marengo, D., Settanni, M., Fabris, M. A., & Longobardi, C. (2021). Alone, together: Fear of missing out mediates the link between peer exclusion in WhatsApp classmate groups and psychological adjustment in early-adolescent teens. *Journal of Social and Personal Relationships*, *38*(4), 1371–1379. https://doi.org/10.1177/0265407521991917

Moisala, M., Salmela, V., Hietajärvi, L., Salo, E., Carlson, S., Salonen, O., Lonka, K., Hakkarainen, K., Salmela-Aro, K., & Alho, K. (2016). Media multitasking is associated with distractibility and increased prefrontal activity in adolescents and young adults. *NeuroImage*, *134*, 113–121. https://doi.org/10.1016/j.neuroimage.2016.04.011

Montag, C., Lachmann, B., Herrlich, M., & Zweig, K. (2019). Addictive Features of Social Media/Messenger Platforms and Freemium Games against the Background of Psychological and Economic Theories. *International Journal of Environmental Research and Public Health*, *16*(14), Article 14. https://doi.org/10.3390/ijerph16142612

Montag, C., Yang, H., & Elhai, J. D. (2021). On the Psychology of TikTok Use: A First Glimpse From Empirical Findings. *Frontiers in Public Health*, *9*. https://doi.org/10.3389/fpubh.2021.641673

Mourra, G. N., Sénécal, S., Fredette, M., Lepore, F., Faubert, J., Bellavance, F., Cameron, A.-F., Labonté-LeMoyne, É., & Léger, P.-M. (2020). Using a smartphone while walking: The cost of smartphone-addiction proneness. *Addictive Behaviors*, *106*, 106346. https://doi.org/10.1016/j.addbeh.2020.106346

Oh, C., & LaPointe, L. L. (2017). Changes in cognitive load and effects on parameters of gait. *Cogent Psychology*, *4*(1). https://doi.org/10.1080/23311908.2017.1372872

Osborne, R., Horberry, P. T., & Young, D. K. (2022). *PEDESTRIAN DISTRACTION FROM SMARTPHONES*.

Oulasvirta, A., Rattenbury, T., Ma, L., & Raita, E. (2012). Habits make smartphone use more pervasive. *Personal and Ubiquitous Computing*, *16*(1), 105–114. https://doi.org/10.1007/s00779-011-0412-2

Oz, B., Coursaris, C., Robert, J., & Léger, P.-M. (2024). The Nature and Dimensionality of Cognitive Absorption: A Critical Review and Meta-Analysis. *SIGHCI 2023 Proceedings*. https://aisel.aisnet.org/sighci2023/18

Pelicioni, P. H. S., Chan, L. L. Y., Shi, S., Kark, L., Okubo, Y., & Brodie, M. A. (2023). Impact of mobile phone use on accidental falls risk in young adult pedestrians. *HELIYON*, *9*(8). https://doi.org/10.1016/j.heliyon.2023.e18366

Pielot, M., de Oliveira, R., Kwak, H., & Oliver, N. (2014). Didn't you see my message? Predicting attentiveness to mobile instant messages. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 3319–3328. https://doi.org/10.1145/2556288.2556973

Pourchon, R., Léger, P.-M., Labonté-LeMoyne, É., Sénécal, S., Bellavance, F., Fredette, M., & Courtemanche, F. (2017). Is Augmented Reality Leading to More Risky Behaviors? An Experiment with Pokémon Go. In *HCI in Business, Government and Organizations* (pp. 354–361). Springer, Cham. https://doi.org/10.1007/978-3-319-58481-2_27

Raoniar, R., & Maurya, A. K. (2023). Digital and social distractions' impact on pedestrian road crossing behavior at signalized intersection crosswalks. *TRANSPORTATION LETTERS-THE INTERNATIONAL JOURNAL OF TRANSPORTATION RESEARCH*. https://doi.org/10.1080/19427867.2023.2233209

Reinsch, N. L., Turner, J. W., & Tinsley, C. H. (2008). Multicommunicating: A Practice Whose Time Has Come? *Academy of Management Review*, *33*(2), 391–403. https://doi.org/10.5465/amr.2008.31193450

Retting, R., & Consulting, S. S. (2017). *Governors Highway Safety Association*.

Schabrun, S. M., van den Hoorn, W., Moorcroft, A., Greenland, C., & Hodges, P. W. (2014). Texting and Walking: Strategies for Postural Control and Implications for Safety. *PLOS ONE*, *9*(1), e84312. https://doi.org/10.1371/journal.pone.0084312

Schwebel, D. C., Canter, M. F., Hasan, R., Griffin, R., White, T. R., & Johnston, A. (2022). Distracted pedestrian behavior: An observational study of risk by situational environments. *Traffic Injury Prevention*, *23*(6), 346–351. https://doi.org/10.1080/15389588.2022.2076282

Schwebel, D. C., Hasan, R., & Griffin, R. (2019). Using Bluetooth beacon technology to reduce distracted pedestrian behaviour: A cross-over trial study protocol. *Injury Prevention*. https://doi.org/10.1136/injuryprev-2019-043436

Scopatz, R. A., & Zhou, Y. (2016). *Effect of Electronic Device Use on Pedestrian Safety: A Literature Review*. National Highway Traffic Safety Administration.

Silva, S. W., Sangani, S., Azevedo, N., Kehayia, E., & Lamontagne, A. (2017). Phone messaging impacts on obstacle circumvention of healthy individuals walking in a virtual environment. *2017 INTERNATIONAL CONFERENCE ON VIRTUAL REHABILITATION (ICVR)*.

Simmons, S. M., Caird, J. K., Ta, A., Sterzer, F., & Hagel, B. E. (2020). Plight of the distracted pedestrian: A research synthesis and meta-analysis of mobile phone use on crossing behaviour. *Injury Prevention*, injuryprev–2019–043426.

https://doi.org/10.1136/injuryprev-2019-043426

Simons, D. J., & Chabris, C. F. (1999). Gorillas in Our Midst: Sustained Inattentional Blindness for Dynamic Events. *Perception*, *28*(9), 1059–1074. https://doi.org/10.1068/p281059

Sobrinho-Junior, S. A., de Almeida, A. C. N., Ceabras, A. A. P., da Silva Carvalho, C. L., Lino, T. B., & Christofoletti, G. (2022). Risks of Accidents Caused by the Use of Smartphone by Pedestrians Are Task- and Environment-Dependent. *INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH*, *19*(16). https://doi.org/10.3390/ijerph191610320

Statista. (2024, February 27). *Number of smartphone users worldwide from 2014 to 2029 (in millions)*. In Statista. https://www.statista.com/forecasts/1143723/smartphone-users-in-the-world

Stavrinos, D., Pope, C. N., Shen, J., & Schwebel, D. C. (2018). Distracted Walking, Bicycling, and Driving: Systematic Review and Meta-Analysis of Mobile Technology and Youth Crash Risk. *Child Development*, *89*(1), 118–128. https://doi.org/10.1111/cdev.12827

Stothart, C., Mitchum, A., & Yehnert, C. (2015). The attentional cost of receiving a cell phone notification. *Journal of Experimental Psychology. Human Perception and Performance*, *41*(4), 893–897. https://doi.org/10.1037/xhp0000100

Syazwan, M. S., Deros, B. Md., Zarifah, N. H., Hafeez, A. A., & Faradila, N. P. (2017). Prevalence of distracted pedestrians while crossing: A study of Malaysia’s situation. In S. Ghani, W. Hamzah, & A. Alias (Eds.), *2ND INTERNATIONAL CONFERENCE ON AUTOMOTIVE INNOVATION AND GREEN VEHICLE (AIGEV 2016)* (Vol. 90). https://doi.org/10.1051/matecconf/20179001031

Thompson, L. L., Rivara, F. P., Ayyagari, R. C., & Ebel, B. E. (2013). Impact of social and technological distraction on pedestrian crossing behaviour: An observational study. *Injury Prevention*, *19*(4), 232–237. https://doi.org/10.1136/injuryprev-2012-040601

Tian, Y., Huang, Y., He, J., & Wei, K. (2018). What affects gait performance during walking while texting? A comparison of motor, visual and cognitive factors. *ERGONOMICS*, *61*(11), 1507–1518. https://doi.org/10.1080/00140139.2018.1493153

TikTok Revenue and Usage Statistics (2024)—Business of Apps. (2024). https://www.businessofapps.com/data/tik-tok-statistics/

Ting, C. H., & Chen, Y. Y. (2020). Chapter 8—Smartphone addiction. In C. A. Essau & P. H. Delfabbro (Eds.), *Adolescent Addiction (Second Edition)* (pp. 215–240). Academic Press. https://doi.org/10.1016/B978-0-12-818626-8.00008-6

Violano, P., Roney, L., & Bechtel, K. (2015). The incidence of pedestrian distraction at urban intersections after implementation of a Streets Smarts campaign. *Injury Epidemiology*, *2*(1), 18. https://doi.org/10.1186/s40621-015-0050-7

Vollrath, M., Huemer, A. K., & Nicolai, C. (2019). Young people use their smartphone all the time – even when crossing the street? *IET Intelligent Transport Systems*, *13*(8), 1213–1217. https://doi.org/10.1049/iet-its.2018.5548

Walsh, L. R., Xian, T. (Tim), Levinson, D., & Rayaprolu, H. S. (2019). WALKING AND TALKING THE EFFECT OF SMARTPHONE USE AND GROUP CONVERSATION ON PEDESTRIAN SPEED. *TEMA-JOURNAL OF LAND USE MOBILITY AND ENVIRONMENT*, *12*(3), 283–292. https://doi.org/10.6092/1970-9870/6088

Wang, H., Li, D., Wang, Q., Schwebel, D. C., Miao, L., & Shen, Y. (2022). How distraction affects pedestrian response: Evidence from behavior patterns and cortex oxyhemoglobin changes. *TRANSPORTATION RESEARCH PART F-TRAFFIC PSYCHOLOGY AND*

BEHAVIOUR, *91*, 414–430. https://doi.org/10.1016/j.trf.2022.10.026

Wu, X., & Santana, S. (2022). Impact of Intrinsic and Extrinsic Gaming Elements on Online Purchase Intention. *Frontiers in Psychology*, *13,* 885619. https://doi.org/10.3389/fpsyg.2022.885619

Yadav, A. K., & Velaga, N. R. (2022). A systematic review of observational studies investigating the influence of mobile phone distraction on road crossing behaviour of pedestrians. *TRANSPORTATION RESEARCH PART F-TRAFFIC PSYCHOLOGY AND BEHAVIOUR*, *91*, 236–259. https://doi.org/10.1016/j.trf.2022.10.008

Yuanyuan, W., Cunbao, Z., Bin, Z., Feng, C., & Hualong, Z. (2017). The Mobile Phone Use Behavior and Its Effect on Pedestrian Safety at Signalized Intersections in China. *2017 4TH INTERNATIONAL CONFERENCE ON TRANSPORTATION INFORMATION AND SAFETY (ICTIS)*, 225–231.

Zhang, H., Zhang, C., Chen, F., & Wei, Y. (2019). Effects of mobile phone use on pedestrian crossing behavior and safety at unsignalized intersections. *CANADIAN JOURNAL OF CIVIL ENGINEERING*, *46*(5), 381–388. https://doi.org/10.1139/cjce-2017-0649

Zhang, X., Li, Q., Gao, P., Zhu, J., Tuo, H., Lin, Q., Jing, F., & Liu, W. (2023). The effect of mobile phone task and age on gait: A systematic review and meta-analysis. *FRONTIERS IN PHYSIOLOGY*, *14*. https://doi.org/10.3389/fphys.2023.1163655

Annexe

Annexe A - Articles Examining Smartphone Multitasking Tasks

Annexe A.1: Articles Examining Smartphone Multitasking Tasks and Pedestrian Performance

Type of task	Pedestrian Walking Behavior & Safety	Gait	Visual Detection**	Auditory Detection	Cognitive Processes	Secondary Task Performance
Texting	**(Almajid et al., 2023)**, **(P. L. Chen & Pai, 2018a)**, **(Chopra et al., 2018)**, **(Haga et al., 2016)**, **(Mourra, Sénécal, et al., 2020)**, **(Pelicioni et al., 2023)**, **(Pourchon et al., 2017)**, **(Raoniar & Maurya, 2023)**, ***(Scopatz & Zhou, 2016)**, **(Silva et al., 2017)**, **(Simmons et al., 2020)*, **(Sobrinho-Junior et al., 2022)**, ***(Stavrinos et al., 2018)**, **(Syazwan et al., 2017)**, ***(Yadav & Velaga, 2022)**	**(Bovonsunthonchai et al., 2020)**, **(Ferraro et al., 2022)**, *(Hinton et al., 2018)*, **(Luo et al., 2023)**, **(Pelicioni et al., 2023)**, **(S.-H. Chen et al., 2018)**, **(Stavrinos et al., 2018)**, **(Tian et al., 2018)**, *(Walsh et al., 2019)*, ***(X. Zhang et al., 2023)**, ***(Yadav & Velaga, 2022)**	**(P.L. Chen & Pai, 2018a)**, **(Kim et al., 2022)**, (Labonte-LeMoyne et al., 2022), **(Wang et al.,2022)**, ***(Yadav & Velaga, 2022)**	**(P.L.Chen & Pai, 2018a)**, **(Haga et al., 2016)**, (S. J. Davis & Barton, 2017). **(Wang et al.,2022)**	**(Haga et al., 2016)**, (Labonte-LeMoyne et al., 2022), **(Wang et al.,2022)**	**(Chopra et al., 2018)**, *(Hinton et al., 2018)*, **(Pelicioni et al., 2023)**
Group Texting	**(Mourra, Sénécal, et al., 2020)**		**(Labonte-LeMoyne et al., 2022)**.		*(Labonte-LeMoyne et al., 2022)*	
Writing Email	***(Scopatz & Zhou, 2016)**		(Labonte-LeMoyne et al., 2022),		(Labonte-LeMoyne et al., 2022)	

Note. Support found - **bold**; Non-supportive - normal; Mixed results – *italic*; Review or Meta-analysis - *; **Visual detection includes Inattentional Blindness and Situational Awareness.

Annexe A.2: Articles Examining Smartphone Multitasking Tasks and Pedestrian Performance

Type of task	Pedestrian Walking Behavior & Safety	Gait	Visual Detection**	Auditory Detection	Cognitive Processes	Secondary Task Performance
Talking on the Phone	**(Dam et al., 2023)**, **(Li & Ming, 2016)**, **(Raoniar & Maurya, 2023)**, ***(Scopatz & Zhou, 2016)**, **(Simmons et al., 2020)*, **(Sobrinho-Junior et al., 2022)**, ***(Stavrinos et al., 2018)**, **(Syazwan et al., 2017)**, (H. Zhang et al., 2019), **(Yadav & Velaga, 2022)*, (Yuanyuan et al., 2017)	**(Bovonsunthonchai et al., 2020)**, **(Stavrinos et al., 2018)**, *(Walsh et al., 2019)*, *(X. Zhang et al., 2023), **(Yadav & Velaga, 2022)*, (Yuanyuan et al., 2017)	*(P.L.Chen & Pai, 2018a)*, **(Wang et al.,2022)**. **(Yadav & Velaga, 2022)*	**(P.L. Chen & Pai, 2018a)**, **(S. J. Davis & Barton, 2017)**, **(S. J. Davis et al., 2021)**, **(Wang et al.,2022)**	**(Wang et al.,2022)**	
Dialing		*(X. Zhang et al., 2023)				
Gaming	**(Mourra, Sénécal, et al., 2020)**, **(P.-L. Chen & Pai, 2018)**, **(Pourchon et al., 2017)**, ***(Scopatz & Zhou, 2016)**	**(Bovonsunthonchai et al., 2020)**, **(Luo et al., 2023)**	**(P.L. Chen & Pai, 2018a)**, **(Labonte-LeMoyne et al., 2022)**	**(P.L. Chen & Pai, 2018a)**	**(Labonte-LeMoyne et al., 2022)**	

Note. Support found - **bold**; Non-supportive - normal; Mixed results – *italic*; Review or Meta-analysis - *; **Visual detection includes Inattentional Blindness and Situational Awareness.

Annexe A.3: Articles Examining Smartphone Multitasking Tasks and Pedestrian Performance

Type of task	Pedestrian Walking Behavior & Safety	Gait	Visual Detection**	Auditory Detection	Cognitive Processes	Secondary Task Performance
Browsing	**(Li & Ming, 2016)**, ***(Scopatz & Zhou, 2016)**, *(Simmons et al., 2020)*, **(H. Zhang et al., 2019)**, **(Yuanyuan et al., 2017)**	*(X. Zhang et al., 2023)	*(P.L.Chen & Pai, 2018a)*	(P.L.Chen & Pai, 2018a)		
Reading	***(Scopatz & Zhou, 2016)**	**(Luo et al., 2023)**, *(Walsh et al., 2019)*, *(X. Zhang et al., 2023)	(Labonte-LeMoyne et al., 2022)		(Labonte-LeMoyne et al., 2022)	
Social Media	**(Gruden et al., 2022)**		**(P.L. Chen & Pai, 2018a)**, **(Gruden et al., 2022)**	(P.L.Chen & Pai, 2018a)		
Watching a Video		**(Bovonsunthonchai et al., 2020)**				
Listening to Music	*(Dam et al., 2023)*, **(Li & Ming, 2016)**, **(Raoniar & Maurya, 2023)**, ***(Scopatz & Zhou, 2016)**, (Simmons et al., 2020), *(Stavrinos et al., 2018)*, **(Syazwan et al., 2017)**, (Zhang et al., 2019), *(Yadav & Velaga, 2022)	(Bovonsunthonchai et al., 2020), (Stavrinos et al., **2018)**, *(X. Zhang et al., 2023), *(Yadav & Velaga, 2022)	*(P. L. Chen & Pai, 2018a)*, **(Wang et al.,2022)**, *(Yadav & Velaga, 2022)	**(P.L. Chen & Pai, 2018a)**, *(S. J. Davis et al., 2021)*, **(Wang et al.,2022)**	**(Wang et al.,2022)**	

Note. Support found - **bold**; Non-supportive - normal; Mixed results – *italic*; Review or Meta-analysis - *; **Visual detection includes Inattentional Blindness and Situational Awareness.

Annexe A.3: Articles Examining Smartphone Multitasking Tasks and Pedestrian Performance

Type of task	Pedestrian Walking Behavior & Safety	Gait	Visual Detection**	Auditory Detection	Cognitive Processes	Secondary Task Performance
Browsing	**(Li & Ming, 2016)**, ***(Scopatz & Zhou, 2016)**, *(Simmons et al., 2020)*, **(H. Zhang et al., 2019)**, **(Yuanyuan et al., 2017)**	*(X. Zhang et al., 2023)	*(P.L.Chen & Pai, 2018a)*	(P.L.Chen & Pai, 2018a)		
Reading	***(Scopatz & Zhou, 2016)**	**(Luo et al., 2023)**, *(Walsh et al., 2019)*, *(X. Zhang et al., 2023)	(Labonte-LeMoyne et al., 2022)		(Labonte-LeMoyne et al., 2022)	
Social Media	**(Gruden et al., 2022)**		**(P.L. Chen & Pai, 2018a)**, **(Gruden et al., 2022)**	(P.L.Chen & Pai, 2018a)		
Watching a Video		**(Bovonsunthonchai et al., 2020)**				
Listening to Music	*(Dam et al., 2023)*, **(Li & Ming, 2016)**, **(Raoniar & Maurya, 2023)**, ***(Scopatz & Zhou, 2016)**, (Simmons et al., 2020), *(Stavrinos et al., 2018)*, **(Syazwan et al., 2017)**, (Zhang et al., 2019), *(Yadav & Velaga, 2022)	(Bovonsunthonchai et al., 2020), (Stavrinos et al., **2018**), *(X. Zhang et al., 2023), *(Yadav & Velaga, 2022)	*(P. L. Chen & Pai, 2018a)*, **(Wang et al.,2022)**, *(Yadav & Velaga, 2022)	**(P.L. Chen & Pai, 2018a)**, *(S. J. Davis et al., 2021)*, **(Wang et al.,2022)**	**(Wang et al.,2022)**	

Note. Support found - **bold**; Non-supportive - normal; Mixed results – *italic*; Review or Meta-analysis - *; **Visual detection includes Inattentional Blindness and Situational Awareness.

Annexe A.4 Non-Mobile Activities Compared to Task Types

Type of task	Pedestrian Walking Behavior & Safety	Gait	Visual Detection**	Auditory Detection	Cognitive Processes	Secondary Task Performance
Crossing with a group of people	*(Dam et al., 2023)*	*(Walsh et al., 2019)*				
Talking with other pedestrians	*(Dam et al., 2023)*, **(Raoniar & Maurya, 2023)**, ***(Scopatz & Zhou, 2016)**, **(Syazwan et al., 2017)**		(Chen & Pai, 2018a)	**(Chen & Pai, 2018a)**		
Holding phone in hand	(Haga et al., 2016)	*(Walsh et al., 2019)*		(Haga et al., 2016)	(Haga et al., 2016)	
Drinking/Eating	*(Raoniar & Maurya, 2023)*, ***(Scopatz & Zhou, 2016)**, **(Syazwan et al., 2017)**					
Smoking	*(Raoniar & Maurya, 2023)*, ***(Scopatz & Zhou, 2016)**, **(Syazwan et al., 2017)**					
Reading	**(Syazwan et al., 2017)**					

Note. Support found - **bold**; Non-supportive - normal; Mixed results – *italic*; Review or Meta-analysis - *; **Visual detection includes Inattentional Blindness and Situational Awareness.

Annexe B - Articles Comparing Smartphone Task Types

Annexe B.1 Studies Comparing Mobile Task Types

	Texting	Group Texting	Writing an Email	Talking on the phone	Dialing	Gaming	Browsing	Reading	Social Media	Watching a video	Listening to music
Texting											
Group Texting	(Labonte-LeMoyne et al., 2022), (Mourra, Sénécal, et al., 2020)										
Writing Email	(Labonte-LeMoyne et al., 2022), *(Scopatz & Zhou, 2016)	(Labonte-LeMoyne et al., 2022)									
Talking on the Phone	(Bovonsunthonchai et al., 2020), (P.L. Chen & Pai, 2018a), (Raoniar & Maurya, 2023), *(Scopatz & Zhou, 2016), *(Simmons et al., 2020), (S. J. Davis & Barton, 2017), *(Stavrinos et al., 2018), *(X. Zhang et al., 2023), *(Yadav & Velaga, 2022), (Wang et al.,2022)		*(Scopatz & Zhou, 2016)								
Dialing	*(X. Zhang et al., 2023)			*(X. Zhang et al., 2023)							

Note. Meta-analysis articles or review articles are noted with *.

Annexe B.2 Studies Comparing Mobile Task Types

	Texting	Group Texting	Writing an Email	Talking on the phone	Dialing	Gaming	Browsing	Reading	Social Media	Watching a video	Listening to music
Gaming	(Bovonsunthonchai et al., 2020), (P.L. Chen & Pai, 2018a), (Labonte-LeMoyne et al., 2022), (Luo et al., 2023), (Mourra, Sénécal, et al., 2020), (Pourchon et al., 2017), *(Scopatz & Zhou, 2016)	(Labonte-LeMoyne et al., 2022), (Mourra, Sénécal, et al., 2020)	(Labonte-LeMoyne et al., 2022), *(Scopatz & Zhou, 2016)	(Bovonsunthonchai et al., 2020), (P.L Chen & Pai, 2018a), *(Scopatz & Zhou, 2016)							
Browsing	(P.L. Chen & Pai, 2018a), *(Scopatz & Zhou, 2016), *(Simmons et al., 2020), *(X. Zhang et al., 2023)		*(Scopatz & Zhou, 2016)	(P.L Chen & Pai, 2018a), *(Scopatz & Zhou, 2016), *(Simmons et al., 2020), *(X. Zhang et al., 2023)	*(X. Zhang et al., 2023)	(P.L Chen & Pai, 2018a), *(Scopatz & Zhou, 2016)					
Reading	(Labonte-LeMoyne et al., 2022), (Luo et al., 2023), *(Scopatz & Zhou, 2016), *(X. Zhang et al., 2023)	(Labonte-LeMoyne et al., 2022)	(Labonte-LeMoyne et al., 2022), *(Scopatz & Zhou, 2016)	*(Scopatz & Zhou, 2016), *(X. Zhang et al., 2023)	*(X. Zhang et al., 2023)	(Labonte-LeMoyne et al., 2022), (Luo et al., 2023), *(Scopatz & Zhou, 2016)	*(Scopatz & Zhou, 2016), *(X. Zhang et al., 2023)				
Social Media	(P.L. Chen & Pai, 2018a)			(P.L Chen & Pai, 2018a)		(P.L Chen & Pai, 2018a)	(P.L Chen & Pai, 2018a)				

Note. Meta-analysis articles or review articles are noted with *.

Annexe B.3 Studies Comparing Mobile Task Types

	Texting	Group Texting	Writing an Email	Talking on the phone	Dialing	Gaming	Browsing	Reading	Social Media	Watching a video	Listening to music
Watching a Video	(Bovonsunthonchai et al., 2020)			(Bovonsunthonchai et al., 2020)		(Bovonsunthonchai et al., 2020)					
Listening to Music	(Bovonsunthonchai et al., 2020), (P.L. Chen & Pai, 2018a), (Raoniar & Maurya, 2023), *(Scopatz & Zhou, 2016), *(Simmons et al., 2020), *(Stavrinos et al., 2018), *(X. Zhang et al., 2023), *(Yadav & Velaga, 2022), (Wang et al.,2022)		*(Scopatz & Zhou, 2016)	(Bovonsunthonchai et al., 2020), (P.L Chen & Pai, 2018a), (Raoniar & Maurya, 2023), (S. J. Davis et al., 2021), *(Scopatz & Zhou, 2016), *(Simmons et al., 2020), *(Stavrinos et al., 2018), *(X. Zhang et al., 2023), *(Yadav & Velaga, 2022), (Wang et al.,2022)	*(X. Zhang et al., 2023)	(Bovonsunthonchai et al., 2020), (P.L Chen & Pai, 2018a), *(Scopatz & Zhou, 2016)	(P.L Chen & Pai, 2018a), *(Scopatz & Zhou, 2016), *(Simmons et al., 2020), *(X. Zhang et al., 2023)	*(Scopatz & Zhou, 2016), *(X. Zhang et al., 2023)	(P.L Chen & Pai, 2018a)	(Bovonsunthonchai et al., 2020)	

Note. Meta-analysis articles or review articles are noted with *.

Annexe C - Cognitive Absorption Scale

English Cognitive Absorption Scale

On a scale from 1 (Strongly disagree) to 7 (Strongly agree), please answer the following questions based on the following statement:

During this walking task…

Temporal Dissociation (TD) Dimension:

- **TD1**. Time appeared to go by very quickly when I was using the smartphone
- **TD2**. Sometimes I lost track of time when I was using the smartphone
- **TD3**. Time flied when I was using the smartphone
- **TD4**. Most times when I get on a smartphone, I end up spending more time that I had planned
- **TD5**. I often spend more time on a smartphone than I had intended.

Focused Immersion (FIM) Dimension:

- **FIM1**. While using the smartphone I was able to block most other distractions
- **FIM2**. While using the smartphone, I was absorbed in what I was doing
- **FIM3**. While on the smartphone, I was immersed in the task I was performing
- **FIM4**. When on the smartphone, I got distracted by other distractions very easily
- **FIM5**. While on the smartphone, my attention did not get diverted very easily.

Heightened Enjoyment (HE) Dimension:

- **HE1**. I had fun interacting with the smartphone.
- **HE2**. Using the smartphone provided me with a lot of enjoyment.
- **HE3**. I enjoyed using the smartphone.
- **HE4**. Using the smartphone bored me.

Control (CON) Dimension:

- **CON1**. When using the smartphone I felt in control.
- **CON2**. I felt that I had no control over my interaction with the smartphone.
- **CON3**. The smartphone allowed me to control my interactions.

Curiosity (CU) Dimension:

- **CU1**. Using the smartphone excited my curiosity.
- **CU2**. Interacting with the smartphone made me curious.
- **CU3**. Using the smartphone aroused my imagination.

French Cognitive Absorption Scale

Sur une échelle de 1 (Pas du tout d'accord) à 7 (Tout à fait d'accord), veuillez répondre aux questions suivantes sur la base de l'affirmation suivante :

Pendant que je marchais…

Temporal Dissociation (TD) Dimension:

- **TD1**. Le temps semblait passer très vite lorsque j'utilisais le téléphone mobile.
- **TD2**. Il m'est arrivé(e) de perdre la notion du temps lorsque j'utilisais le téléphone mobile.
- **TD3**. Le temps est passé vite lorsque j'utilisais le téléphone mobile.
- **TD4**. La plupart du temps, lorsque j'utilise un téléphone mobile, je passe plus de temps que prévu sur celui-ci.
- **TD5**. Je passe souvent plus de temps sur un téléphone mobile que prévu.

Focused Immersion (FIM) Dimension:

- **FIM1**. Pendant que j'utilisais le téléphone mobile, j'ai pu bloquer la plupart des autres distractions.
- **FIM2**. Pendant que j'utilisais le téléphone mobile, j'étais absorbé(e) par ce que je faisais.

- **FIM3**. Lorsque j’étais sur le téléphone mobile, j’étais immergé(e) dans la tâche que j’étais en train d’accomplir.
- **FIM4**. Lorsque j’étais sur le téléphone mobile, je me laissais très facilement distraire par d’autres éléments distrayants.
- **FIM5**. Lorsque j’étais sur le téléphone mobile, mon attention n’a pas été détournée très facilement.

Heightened Enjoyment (HE) Dimension:

- **HE1**. J’ai eu du plaisir à interagir avec le téléphone mobile.
- **HE2**. L’utilisation du téléphone mobile m’a procuré beaucoup de plaisir.
- **HE3**. J’ai apprécié mon utilisation du téléphone mobile.
- **HE4**. L’utilisation du téléphone mobile m’a ennuyé.

Control (CON) Dimension:

- **CON1**. Lorsque j’utilisais le téléphone mobile, je me sentais en contrôle.
- **CON2**. J’ai eu l’impression de n’avoir aucun contrôle sur mon interaction avec le téléphone mobile.
- **CON3**. Le téléphone mobile m’a permis de contrôler mes interactions.

Curiosity (CU) Dimension:

- **CU1**. L’utilisation du téléphone mobile a éveillé ma curiosité.
- **CU2**. L’interaction avec le téléphone mobile m’a rendu curieux(-se).
- **CU3**. L’utilisation du téléphone mobile a éveillé mon imagination.

Annexe D - Recall Accuracy Questionnaires

English Questionnaire

Recall Accuracy of Time (English Version):

How much time, in total, do you think the entire task lasted? From the first sound signal "Go", to the last sound signal "Stop".

Please answer in the number of minutes.

Recall Accuracy of Environment (English Version):

1. How many different times did you see the letter "A" during the task?
2. How many different times did you see the letter "B" during the task?
3. How many different times did you see the letter "C" during the task?
4. How many different times did you see the letter "D" during the task?

French Questionnaire

Recall Accuracy of Time (French Version):

Combien de temps, au total, pensez-vous que la tâche complète a duré? Du premier signal sonore "Go" au dernier signal sonore "Stop".

Veuillez indiquer le nombre de minutes.

Recall Accuracy of Environment (French Version):

1. Combien de fois avez-vous vu la lettre "A" pendant la tâche ?
2. Combien de fois avez-vous vu la lettre "B" pendant la tâche ?
3. Combien de fois avez-vous vu la lettre "C" pendant la tâche ?
4. Combien de fois avez-vous vu la lettre "D" pendant la tâche ?

Annexe E - Conversation Script in English and French

English Conversation Script

1. Hi! How are you doing?
2. What university do you go to?
    a. What is your study program?
    b. How much time do you have left before finishing this study program?
    c. Do you have a student job?
    d. If they have already finished their program: In which year? Have you been to the scholarship's ceremony? Do you work? Where do you work? Do you like the job market better? Why?
3. In which country is your hometown?
    a. What is your hometown?
    b. What high school did you go to?
    c. What school / sport activities did you participate in during high school? (If none, why? No activity interested you?)
    d. Do you still partake in these activities today?
4. What is the means of transportation that you use most often to get around?
    a. *If metro / bus:* Would you like to have a car?
    b. *If car:* Do you have a car? / Have you ever had a car?
        i. If yes, What brand is it?
        ii. What color is it?
        iii. How long have you had it?
    c. What would be your ideal means of transportation to get around?
    d. What means of transportation do you use to go to your school?
    e. What means of transportation do you use to get to your home?
5. On another subject, do you often watch television?
    a. What is your favorite television show?
    b. What do you like about this TV show?
    c. Who are the main actors in this TV show?
    d. Do you watch hockey?
        i. *If yes*:
            1. Do you like the Montreal Canadiens Team?
            2. Are you currently watching the series?
            3. Have you already been to the Bell Centre? Would you like to go?
        ii. *If no: next question*
    e. Do you watch other sports on TV? What is your favorite club?
6. What is your favorite animal?

    a. Have you ever seen one in real life?
7. Do you have any pets?
    a. *If yes:* What is your pet's name?
    b. *If no: next question*
8. What is the most interesting thing that you have done this week?
    a. What is the most interesting thing that you have done this weekend?
    b. How was your morning / afternoon? Were you busy?
    c. Do you have plans tonight?
        i. What are they?
        ii. *If no plans: next question*
9. What did you eat for breakfast?
    a. Do you eat the same thing every morning?
    b. What did you eat for lunch?
10. What was the last place that you traveled to?
    a. Was this trip for pleasure or done in a professional setting?
    b. What is your dream destination?
    c. Do you have any vacation trips planned for this summer?
        i. *If yes:*
            1. Where are you going?
            2. Are you looking forward to it?
        ii. *If no plans: next question*
11. Have you ever met anyone famous?
    a. Who was this person?
    b. Where did you meet them?
    c. Did you have the opportunity to talk to them?
    d. Would you have liked to talk to them?
12. What is the title of your favorite movie?
    a. When did you watch it for the first time?
    b. Have you seen this movie several times?
    c. Do you want to watch it again?
13. What is your favorite food?
    a. When did you have the opportunity to eat it?
    b. Do you eat it often?
    c. Do you only eat it when you go to a restaurant?
14. What is your favorite restaurant?
    a. Do you go often?
    b. Is it a chain restaurant?
15. When you were a kid, what did you want to be when you grew up?
    a. Has this changed?

    b. Why?

16. What is your favorite type of music?
    a. What is your favorite band?
    b. Have you ever been to one of their concerts?
        i. In what city was this show?
    c. Would you like to meet them in person?
17. Have you read any books recently?
    a. What was the title of the book?
    b. What are your favorite kinds of books?
18. Do you often go to bars?
    a. Do you have a favorite bar?
    b. Do you go there often?
19. What do you like to do for fun when you have some free time?
    a. What is your favorite activity to do during the weekend?
    b. Do you prefer to spend your time indoors or outdoors?
20. What is your favorite sport? The one you usually practice.
    a. How many hours per week do you spend practicing this sport?
21. Have you seen any good movies at the movie theater recently?
    a. What did you like about this movie?
    b. b. Who were the main actors in this movie?
    c. c. Do you often go to the movie theater?
22. What were your favorite courses at school during this last semester?
    a. Which courses did you like the least?
    b. What courses are you taking next semester?
23. How many brothers and sisters do you have?
    a. Are your siblings older or younger than you?
24. Do you enjoy playing video games?
    a. Do you play regularly?
    b. What gaming consoles do you own?
25. Do you play gaming applications on your phone?
    a. Since when?
    b. Which ones?
    c. Do you like it?
26. What is your favorite clothing line?
    a. Do you shop there often?
27. Do you currently do any volunteer work?
    a. Have you done so in the past?
    b. b. Where have you done it? How often?
28. What is your astrological sign?

a. Do you often look at horoscopes?
b. Where do you find your horoscopes?

French Conversation Script

1. Bonjour ! Comment allez-vous ?
2. Quelle est votre université ?
    a. Quel est votre programme d'études ?
    b. Combien de temps vous reste-t-il avant de terminer ce programme d'études ?
    c. Avez-vous un job étudiant ?
    d. S'ils ont déjà terminé leur programme : En quelle année avez-vous terminé ? Avez-vous assisté à la cérémonie de remise des bourses ? Travaillez-vous ? Où travaillez-vous ? Le marché du travail vous plaît-il davantage ? Pourquoi ?
3. Dans quel pays se trouve votre ville natale ?
    a. Quelle est votre ville natale ?
    b. Quelle école secondaire avez-vous fréquentée ?
    c. Quelles activités scolaires ou sportives avez-vous pratiquées au cours de vos études secondaires ?
        i. Participez-vous encore à ces activités aujourd'hui ?
        ii. (Si vous n'en avez pratiqué aucune, pourquoi ? Aucune activité ne vous intéressait ?)
4. Quel est le moyen de transport que vous utilisez le plus souvent pour vous déplacer ?
    a. *Si métro / bus:* Souhaiteriez-vous avoir une voiture ?
    b. Avez-vous une voiture ? / Avez-vous déjà eu une voiture ?
        i. Si oui, de quelle marque est-elle ?
        ii. De quelle couleur est-elle ?
        iii. Depuis combien de temps la possédez-vous ?
    c. Quel serait votre moyen de transport idéal pour vous déplacer ?
    d. Quel moyen de transport utilisez-vous pour vous rendre à votre école ?
    e. Quel moyen de transport utilisez-vous pour vous rendre à votre domicile ?
5. Regardez-vous souvent la télévision ?
    a. Quelle est votre émission préférée ?
    b. Qu'est-ce qui vous plaît dans cette émission ?
    c. Quels sont les principaux acteurs de cette émission ?
    d. Regardez-vous le hockey ?
        i. *Si oui:*
            1. Aimez-vous l'équipe des Canadiens de Montréal ?
            2. Êtes-vous en train de regarder la série ?
            3. Êtes-vous déjà allé au Centre Bell ? Aimeriez-vous y aller ?

   - ii. *Si non: prochaine question*
   e. Regardez-vous d'autres sports à la télévision ? Quel est votre club préféré ?

6. Quel est votre animal préféré ?
   a. En avez-vous déjà vu un dans la vie réelle ?
7. Avez-vous des animaux de compagnie ?
   a. *Si oui:*
      i. Quel est le nom de votre animal ?
   b. Si non: prochaine question
8. Quelle est la chose la plus intéressante que vous ayez faite cette semaine ?
   a. Quelle est la chose la plus intéressante que vous ayez faite ce week-end ?
   b. Comment s'est déroulée votre matinée/après-midi ? Avez-vous été occupé(e) ?
   c. Avez-vous des plans pour ce soir ?
      i. Quels sont ces plans?
9. Qu’avez-vous mangé ce matin?
   a. Mangez-vous la même chose tous les matins ?
   b. Qu'avez-vous mangé à midi?
10. Quel est le dernier endroit où vous avez voyagé ?
   a. S'agissait-il d'un voyage pour vous ou d'un voyage professionnel ?
   b. Quelle est la destination de vos rêves ?
   c. Avez-vous prévu de partir en vacances cet été ?
      i. Si oui:
         1. Où allez-vous ?
         2. Avez-vous hâte d'y aller ?
      ii. Si non: prochaine question
11. Avez-vous déjà rencontré une personne célèbre ?
   a. *Si oui:*
      i. Qui était cette personne ?
      ii. Où l'avez-vous rencontrée ?
      iii. Avez-vous eu l'occasion de lui parler ?
      iv. Auriez-vous aimé lui parler ?
   b. Si non: prochaine question
12. Quel est le titre de votre film préféré ?
   a. Quand l'avez-vous vu pour la première fois ?
   b. Avez-vous vu ce film plusieurs fois ?
   c. Souhaitez-vous le revoir ?
13. Quel est votre plat préféré ?
   a. Quand avez-vous eu l'occasion d’en manger ?
   b. En mangez-vous souvent ?
   c. En mangez-vous seulement lorsque vous allez au restaurant ?

14. Quel est votre restaurant préféré ?
    a. Y allez-vous souvent ?
    b. S'agit-il d'une chaîne de restaurants ?
15. Quand vous étiez enfant, que vouliez-vous faire plus tard ?
    a. Cela a-t-il changé ?
    b. Pourquoi ?
16. Quel est votre type de musique préféré ?
    a. Quel est votre groupe préféré ?
    b. Avez-vous déjà assisté à l'un de leurs concerts ?
        i. Si ouiDans quelle ville s'est déroulé ce concert ?
    c. Aimeriez-vous les rencontrer en personne ?
17. Avez-vous lu des livres récemment ?
    a. Quel était le titre du livre ?
    b. Quel est votre genre de livre préféré ?
18. Allez-vous souvent dans des bars ?
    a. Avez-vous un bar préféré ?
    b. Y allez-vous souvent ?
19. Qu'aimez-vous faire pour vous amuser lorsque vous avez du temps libre ?
    a. Quelle est votre activité préférée pendant le week-end ?
    b. Préférez-vous passer votre temps à l'intérieur ou à l'extérieur ?
20. Quel est votre sport préféré ? Celui que vous pratiquez habituellement.
    a. Combien d'heures par semaine consacrez-vous à la pratique de ce sport ?
21. Avez-vous vu récemment de bons films au cinéma ?
    a. Qu'avez-vous aimé dans ce film ?
    b. Quels étaient les principaux acteurs de ce film ?
    c. Allez-vous souvent au cinéma ?
22. Quels sont les cours que vous avez préférés à l'école au cours du dernier semestre ?
    a. Quels sont les cours que vous avez le moins aimés ?
    b. Quels sont les cours que vous suivrez le semestre prochain ?
23. Combien de frères et sœurs avez-vous ?
    a. Vos frères et sœurs sont-ils plus âgés ou plus jeunes que vous ?
24. Aimez-vous jouer aux jeux vidéo ?
    a. Jouez-vous régulièrement ?
    b. Quelles consoles de jeu possédez-vous ?
25. Jouez-vous à des applications de jeux sur votre téléphone ?
    a. Depuis quand ?
    b. Lesquelles ?
    c. Les aimez-vous ?
26. Quelle est votre ligne de vêtements préférée ?

a. Y faites-vous souvent des achats ?

27. Faites-vous actuellement du bénévolat ?
    a. L'avez-vous déjà fait par le passé ?
    b. Où l'avez-vous fait ? A quelle fréquence ?
28. Quel est votre signe astrologique ?
    a. Regardez-vous souvent les horoscopes ?
    b. Où trouvez-vous vos horoscopes ?