Towards a Holistic Understanding of the Drivers of Media Multitasking

by

Allison Caroline Drody

A thesis

presented to the University of Waterloo

in fulfillment of the

thesis requirement for the degree of

Doctor of Philosophy

in

Psychology

Waterloo, Ontario, Canada, 2025

© Allison Caroline Drody 2025

Examining Committee Membership

The following served on the Examining Committee for this thesis. The decision of the Examining Committee is by majority vote.

External Examiner	Dr. Karen Arnell Professor, Psychology Brock University
Supervisor	Dr. James Danckert Professor, Psychology University of Waterloo
Supervisor	Dr. Daniel Smilek Professor, Psychology University of Waterloo
Internal Member	Dr. Myra Fernandes Professor, Psychology University of Waterloo
Internal Member	Dr. Evan Risko Professor, Psychology University of Waterloo
Internal-external Member	Dr. Marcel O'Gorman Professor, English University of Waterloo

Author's Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Statement of Contributions

Allison C. Drody was the primary author of all the chapters in the present thesis. She was responsible for the conceptualization and design of the studies, as well as data collection, analysis and interpretation.

Dr. Effie J. Pereira contributed to the study design for the work presented in Chapters 3 through 5 and contributed to the theoretical model presented in Chapter 6.

Dr. Brandon Ralph contributed to the study design for the work presented in Chapters 2 and 3.

Dr. James Danckert and **Dr. Daniel Smilek** provided guidance throughout all stages of the research process (i.e., conceptualization, design, data analysis and interpretation, reviewing and editing chapters) for all of the chapters.

A version of Chapter 2 is available in Drody, A. C., Ralph, B. C., Danckert, J., & Smilek, D. (2024). Do rising opportunity costs lead to increases in media multitasking over time?. *Media Psychology*, *27*(1), 135-160. https://doi.org/10.1080/15213269.2023.2227562, and a version of Chapter 3 is available in Drody, A. C., Pereira, E. J., Danckert, J., & Smilek, D. (2025). Inattention over time-on-task: The role of motivation in mitigating temporal increases in media multitasking. *Frontiers in Cognition*, 4, 1547295. https://doi.org/10.3389/fcogn.2025.1547295. The description of the theoretical model proposed in Chapter 6 is based on the following published article: Drody, A. C., Pereira, E. J., & Smilek, D. (2025). Attention in our digital ecosystem: The five interactive components that drive media multitasking. *Psychonomic Bulletin & Review*, 1-18.

Abstract

Media multitasking, defined as simultaneously engaging with multiple tasks when at least one of the tasks involves media, is a highly prevalent behaviour known to negatively impact performance across a variety of contexts. It is therefore crucial to understand what motivates individuals to engage in this behaviour. The studies presented in this thesis examined participants' decisions to engage in media multitasking during sustained attention tasks, along with the predictors of these decisions, to provide a more nuanced understanding of the drivers of media multitasking. Chapter 1 discusses the current media multitasking literature, highlighting a need for further research investigating the variables that underly changes in this behaviour over time, as well as research investigating the combined role of individual differences and contextual factors in media multitasking. Chapters 2 and 3 explored whether variables relevant to the perceived opportunity costs of completing a task, namely boredom and motivation, are associated with changes in media multitasking over time. Chapter 2 provided evidence that rising opportunity costs, signaled by increases in boredom over time, may drive temporal increases in media multitasking. Across two studies, Chapter 3 demonstrated that increasing motivation attenuates temporal increases in media multitasking. Chapters 4 and 5 examined the joint role of individual differences and contextual factors in predicting media multitasking. Chapter 4 specifically explored the interactions between these two classes of factors, revealing that relations between in-study media multitasking and individual differences in attention-related and self-regulatory traits, as well as real-world media multitasking tendencies varied based on two key contextual variables: whether participants were completing an easy or challenging task and the order in which they completed these tasks. Chapter 5 tested the assumption that, if media

multitasking arises from a combination of individual differences and contextual factors, then when context is held constant over time, patterns of media multitasking should remain consistent. Moreover, this consistency should largely be driven by individual differences. Media multitasking was assessed in the same laboratory context on two separate occasions and was found to be consistent across sessions. Additionally, several individual difference factors interacted with session when predicting media multitasking. For the most part, relations involving these factors varied in strength, but not direction across sessions. The final chapter (Chapter 6) summarizes the work presented in this thesis, contextualizes it within the current literature, and emphasizes the need for further work investigating how factors within various layers of influence interact to give rise to media multitasking. This chapter also proposes a novel framework for considering and guiding future research on these interactions.

Acknowledgements

I would like to express my sincere gratitude to my supervisors, Dr. James Danckert and Dr. Daniel Smilek for their guidance throughout my degree. I have learned more than I thought possible working with you, and your passion for research and commitment to student development have made this a truly enjoyable and rewarding experience. I am also grateful to the members of my committee for volunteering their time. Special thanks to Dr. Evan Risko and Dr. Myra Fernandes for taking the time to offer feedback on my thesis.

This degree would not have been possible without the love and support of my parents, Irene and Burton Drody, my brother, Spencer Drody, and my grandparents, Alice and Andrew Lingam. A special thank you as well to Uncle Mike, Auntie Roselyn, Auntie Maureen, Uncle Tony, Auntie Magdaline and Uncle Ariel, as well as Alan Dawson, and Lorene and Ken Yonemura.

To my partner, Michael Taylor, thank you for your support and belief in me throughout this degree. I am also thankful for the labmates I have had the pleasure of befriending both here and during my time at UBC, especially Jessica Lee, Baaba Dadzie, Jamie Nettinga, Chantal Trudel, Austin Hurst, Dr. Alyssa Smith, Dr. Jeremy Marty-Dugas and Dr. Quentin Raffaelli. I have been fortunate to collaborate with Dr. Effie Pereira and Dr. Brandon Ralph, who have been wonderful colleagues and mentors throughout this degree.

Thank you as well to my amazing research assistant, Patricia Encarnacion, and to my dear friend, Pranav Athavale. Finally, I am eternally grateful to my best friend, Jessica Lee, for making me laugh every day, and for keeping me happy, fed, and, most importantly, caffeinated over the past few years! I'm so lucky to have you as a best frond ("apes together, strong!").

Table of Contents

Examining Committee Membership……ii

Author's Declaration iii

Statement of Contributions iv

Abstract v

Acknowledgements vii

List of Figures xii

List of Tables xv

List of Abbreviations xvii

Chapter 1: General Introduction 1

1.1 The Present Investigations 8

Chapter 2: Do rising opportunity costs lead to increases in media multitasking over time? 13

2.1 Introduction 13

2.2 Methods 16

2.2.1 Participants 16

2.2.2 Materials 16

2.2.3 Procedure 20

2.3 Results 20

2.3.1 Data Preprocessing 20

2.3.2 Data Analysis Overview 21

2.3.3 Media Multitasking 22

2.3.4 State Boredom 22

2.3.5 Effort 23

2.3.6 1-back Performance 25

2.3.7 Exploratory Analyses 26
2.4 Discussion 29
Chapter 3: Inattention over time-on-task: The role of motivation in mitigating temporal increases in media multitasking 33
3.1 Introduction 33
3.3 Study 3.1 35
3.2.1 Materials and Methods 35
3.2.2 Results 37
3.2.3 Discussion 41
3.2 Study 3.2 42
3.3.1 Materials and Methods 42
3.3.2 Results 45
3.3.3 Discussion 50
3.4 General Discussion 51
Chapter 4: Interactions between individual differences and contextual factors 53
4.1 Introduction 53
4.2 Methods 56
4.2.1 Participants 56
4.2.2 N-back Tasks and Media Multitasking 57
4.2.3 Probes 58
4.2.4 Individual Difference Factors 58
4.2.5 Media Multitasking Questionnaires 61
4.2.6 Post-Task Extra-Experimental Media Multitasking Question 62
4.3 Results 63

4.3.1 Media Multitasking 63
4.3.2 Boredom and Effort 65
4.3.3 Task Performance 66
4.3.4 Individual Difference Factors and Media Multitasking 68
4.3.5 Extra-Experimental Media Multitasking 81
4.4 Discussion 85
Chapter 5: Do individual difference factors predict media multitasking when context is held constant over time? 87
5.1 Introduction 87
5.2 Methods 88
5.2.1 Participants 88
5.2.2 1-back Task and Media Multitasking 88
5.2.3 Video and Task Enjoyment 89
5.2.4 Post-Task Survey 89
5.2.5 Data Analyses 90
5.3 Results 90
5.3.1 Media Multitasking 90
5.3.2 Performance 92
5.3.3 Task and Video Enjoyment 93
5.3.4 Individual Difference Factors and Media Multitasking 95
5.4 Discussion 104
Chapter 6: General Discussion 109
6.1 General Summary of Findings 109
6.2 A Holistic Approach to Considering Media Multitasking 112

6.2.1 The Five Interactive Components That Drive Media Multitasking 112

6.2.2 Understanding the Complexity of Media Multitasking 116

References 119

Appendix A 141

Appendix B 152

Appendix C 156

Appendix D 159

List of Figures

Figure 2.1. Image of the 1-back in the Choice condition when the video was turned on (left) and when the video was turned off or unavailable (i.e., in the No-Choice condition; right)……18

Figure 2.2. (A) Line graph depicting the percentage of participants who played the video (i.e., media multitasked) on each trial of the 1-back. (B) Mean (±SE) ratings of state boredom as a function of probe position and Choice condition. (C) Mean (±SE) ratings of effort as a function of probe position and Choice condition……24

Figure 2.3. (A) Graph showing mean (±SE) proportion of hits for participants in the Choice and No-Choice conditions for each block of the 1-back. (B) Mean (±SE) proportion of false alarms as a function of block and Choice condition……...25

Figure 2.4. Mean (±SE) ratings of (A) state boredom and (B) effort for participants in the Extra-Experimental MMT and No MMT conditions as a function of probe position……28

Figure 2.5. Graph showing (A) mean (±SE) proportion of hits for participants in the Extra-Experimental MMT and No MMT conditions for each block of the 1-back. (B) Mean (±SE) proportion of false alarms for participants in the Extra-Experimental MMT and No MMT conditions for each block of the 1-back……29

Figure 3.1. Graph depicting mean (±SE) levels of motivation before and after participants completed the 1-back task……...……....38

Figure 3.2. Scatterplots depicting changes in media multitasking over successive blocks of the 1-back for participants in the Control condition (left) and Motivated condition (right). Data points are jittered to increase their visibility. Regression lines are fitted to the data and shading represents 95% confidence intervals……..40

Figure 3.3. Line graphs depicting mean (±SE) proportion of hits (A) and false alarms (B) over successive blocks of the 1-back task as a function of condition. ……....41

Figure 3.4. Graphs depicting mean (±SE) levels of motivation before and after the 1-back (A) as well as over successive blocks of the 1-back (B) as a function of condition. …….....46

Figure 3.5. Scatterplots illustrating changes in media multitasking over successive blocks of the 1-back for those in the Control condition (left) and Motivated condition (right). Data points are jittered to increase their visibility. Regression lines are fitted to the data and shading represents 95% confidence intervals……..…..48

Figure 3.6. Line graphs depicting mean (±SE) proportion of hits (A) and proportion of false alarms (B) over successive blocks of the 1-back for participants in the Motivated and Control conditions. ……49

Figure 4.1. Average (±SE) number of trials spent media multitasking (A) as a function of task order and difficulty or (B) as a function of experimental phase and task difficulty. Individual data points are jittered to increase their visibility……....65

Figure 4.2. Mean (±SE) ratings of boredom (A) and effort (B), as well as proportion of hits (C) and proportion of false alarms (D) as a function of task order and difficulty……67

Figure 4.3. Scatterplots depicting relations between scores on the attention-related trait measures and media multitasking during the 0-back and 2-back based on task order. Data points are jittered to increase their visibility. Regression lines are fitted to the data and shading represents 95% confidence intervals……..74

Figure 4.4. Scatterplots depicting the relations between scores on the measures of conscientiousness, self-control and boredom proneness and media multitasking during the 0-back and 2-back based on task order. Data points are jittered to increase their visibility. Regression lines are fitted to the data and shading represents 95% confidence intervals…….78

Figure 4.5. Scatterplots depicting the relations between scores on the Media Multitasking Index (A) and the Short Media Multitasking Measure (B) and media multitasking during the 0-back and 2-back based on task order. Data points are jittered to increase their visibility. Regression lines are fitted to the data and shading represents 95% confidence intervals…….....81

Figure 4.6. Boxplots depicting scores on individual difference factors as a function of responses to the post-task media multitasking question. The Extra-Experimental MMT group consists of participants who engaged in activities outside the experimental context while completing the study. The No MMT group consists of participants who only engaged with content relevant to the experiment. Plots are only shown for measures which differed significantly as a function of responses to the post-task question ($ps < .05$)……84

Figure 5.1. (A) Scatterplot depicting the relation between the total trials participants spent media multitasking at Session 1 and media multitasking at Session 2. (B) Graph depicting total trials participant spent media multitasking at each timepoint and for each video. Large points indicate means, while error bars represent +/- 1 standard error of the mean. Individual data points are jittered to increase their visibility……...92

Figure 5.2. Bar graphs depicting mean (±SE) (A) proportion of hits, (B) proportion of false alarms, (C) task enjoyment, and (D) video enjoyment as a function of video and session. Note that the colours in this graph represent the video participants viewed rather than their assigned video order condition……..…...94

Figure 5.3. Predicted relations between total trials spent media multitasking and (A) attention-related cognitive errors, (B) attention lapses, (C) spontaneous mind-wandering, and (D)

deliberate mind-wandering based on results of the GLMMs, which control for video order. The shaded regions represent 95% confidence intervals.……...99

Figure 5.4. Predicted relations between total trials spent media multitasking and (A) conscientiousness, (B) self-control, and (C) boredom proneness based on results of the GLMMs, which control for video order. The shaded regions represent 95% confidence intervals…….……..102

Figure 5.5. Predicted relations between total trials spent media multitasking and scores on the (A) Media Multitasking Index and (B) Short Media Multitasking Measure based on results of the GLMMs, which control for video order. The shaded regions represent 95% confidence intervals. Confidence intervals for the Media Multitasking Index exceed the possible range of media multitasking trials in this study and are therefore cut off at more extreme scores on the Media Multitasking Index…….....104

Figure 6.1. Depiction of the five components within the interactive model of media multitasking, which exist on a core temporal dimension that ranges from stable and intrinsic (above, pink) to transient and mutable (below, blue)……115

Figure 6.2.2. Graphical depiction of a hypothetical scenario in which (A) two individuals with different levels of boredom proneness show a similar likelihood of media multitasking due to differences within the environmental component, and (B) the same individual has a different likelihood of media multitasking over consecutive days due to variability within the task valuation component. In both figures, the size and opacity of the ovals represent the degree to which each component is expected to impact one's decision to media multitask……..117

List of Tables

Table 3.1. GLMM Predicting Changes in Media Multitasking Based on Block and Condition…….....39

Table 3.2. GLMM Results With Block, Condition and Their Interaction Predicting Media Multitasking……...47

Table 4.1. Descriptive Statistics for Media Multitasking as a Function of Task Order and Difficulty……...64

Table 4.2. GLMM Results for Media Multitasking as a Function of Task Order and Difficulty……...64

Table 4.3. Descriptive Statistics for Individual Difference Factors…….....69

Table 4.4. GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty, and Attention-Related Cognitive Errors Scores…….70

Table 4.5. GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Scores on the Lapses-Only variant of the Mindful Attention Awareness Scale…….....71

Table 4.6. GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Scores on the Spontaneous Mind-Wandering Scale…….72

Table 4.7. GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Scores on the Deliberate Mind-Wandering Scale…….73

Table 4.8. GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Conscientiousness Scores……....75

Table 4.9. GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Scores on the Brief Self-Control Scale…….76

Table 4.10. GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Scores on the Short Boredom Proneness Scale ……...……77

Table 4.11. GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Media Multitasking Index Scores……79

Table 4.12. GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Short Media Multitasking Measure Scores……...80

Table 5.1. GLMM Results for Media Multitasking as a Function of Session and Video Order…….....91

Table 5.2. Descriptive Statistics and Between-Session Correlations for Individual Difference Measures……...96

Table 5.3. GLMM Results for Media Multitasking as a Function of Session and the Attention-Related Measures, Controlling for Video Order…….....98

Table 5.4. GLMM Results for Media Multitasking as a Function of Session and the Self-Regulatory Traits, Controlling for Video Order……...101

Table 5.5. GLMM Results for In-Study Media Multitasking as a Function of Session and Media Multitasking Tendencies in Daily Life, Controlling for Video Order……103

List of Abbreviations

Extra-Experimental MMT	Extra-experimental media multitasking
No MMT	No media multitasking
GLMM	Generalized Linear Mixed Model

Chapter 1: General Introduction

Modern digital devices, such as smartphones and laptops, afford individuals great convenience and utility, enabling them to engage in a wide range of activities regardless of the time or their location. As a result, these devices have become an integral part of daily life and are used frequently, often alongside other activities. For instance, individuals commonly listen to music while studying (Calderwood et al., 2014; Goltz & Sadakata, 2021; Serpil, 2015), engage with social media in workplace settings (Cao & Yu, 2019; Charoensukmongkol, 2014; Wushe & Shenje, 2019), and attend to their phones during face-to-face interactions (Al-Saggaf & Macculloch, 2018; Aygar et al., 2021; Barbed-Castrejón et al., 2024). These behaviours exemplify the highly prevalent phenomenon of media multitasking. While definitions of media multitasking differ across studies (Lang & Chrzan, 2015), a description that aligns with most conceptualizations of this behaviour is that it entails concurrently completing multiple tasks when at least one of them involves digital media (Beuckels et al., 2021; Lang & Chrzan, 2015; Ophir et al., 2009). In this context, digital media refers to content that is created, distributed and viewed through electronic devices (Klein, 2023).

There are cases in which individuals may prefer media multitasking over single tasking. For example, media multitasking during less desirable tasks such as reading a boring article or watching televised ads, can help speed the perceived passage of time and promote greater task enjoyment (Chinchanachokchai et al., 2015; Xu & David, 2018). Nevertheless, this behaviour requires dividing one's attention across multiple tasks, which can negatively impact performance (Demirbilek & Talan, 2018; Hembrooke & Gay, 2003; Lopez & Orr, 2022; Ralph et al., 2019, 2020, 2021; Tassone et al., 2020; Wammes et al., 2019). Supporting this notion, laboratory studies have demonstrated that media multitasking impairs performance on cognitive tasks (Lopez & Orr, 2022; Ralph et al., 2019, 2020, 2021). This behaviour has also been shown to reduce efficiency in reading (Bowman et al.,

2010; Fox et al., 2009) and homework completion (Bellur et al., 2015). When engaged in during class lectures, media multitasking has been associated with poorer academic performance (Demirbilek & Talan, 2018; Gingerich & Lineweaver, 2014; Hembrooke & Gay, 2003; Tassone et al., 2020; Wammes et al., 2019), and there is substantial evidence to suggest that media multitasking while driving increases the risk of collisions (Klauer et al., 2014; Stavrinos et al., 2013; Voinea et al., 2023).

While it is well-established that media multitasking can have detrimental effects, less is known about why individuals engage in this behaviour. Understanding what motivates media multitasking is important for gaining deeper insight into what drives our attentional focus as well as identifying ways of mitigating the negative effects associated with this behaviour. To date, research investigating the predictors of media multitasking has primarily followed two distinct approaches: the first involves examining relations between questionnaire measures of media multitasking and various individual difference factors (e.g., Baumgartner et al., 2014; Duff et al., 2014; Jeong & Fishbein, 2007; Magen, 2017; Ophir et al., 2009; Shin et al., 2020). The second focuses on studying media multitasking in specific contexts (e.g., classroom or laboratory settings; Brasel & Gips, 2017; Calderwood et al., 2014; Demirbilek & Talan, 2018; Wammes et al., 2019) to identify situational factors with more immediate effects on this behaviour.

Much of the foundational research on media multitasking has employed the Media Multitasking Index (Ophir et al., 2009), or its variants (e.g., Baumgartner et al., 2017; Rioja et al., 2023), to assess the extent to which individuals combine different forms of media in daily life. This work has sought to uncover the correlates of frequent media multitasking by linking scores on these questionnaires to a variety of individual difference factors. Within this literature, relations have been found between frequent media multitasking and numerous dispositional traits, including high levels of extraversion and neuroticism and low levels of conscientiousness (Loh & Kanai, 2014; Ma et al.,

2024; Shukla, 2021; Toyama & Hayashi, 2023). Frequent media multitasking has also been associated with low self-control (Luo et al., 2024; Shin et al., 2019; Xu et al., 2016), high impulsivity (Hayashi & Nenstiel, 2021; Rioja et al., 2023; Sanbonmatsu et al., 2013; Shin et al., 2019; Yang & Zhu, 2016) and poor time management (Yang et al., 2015; Yang & Zhu, 2016). Beyond its relations with dispositional traits, media multitasking has been associated with poor cognitive performance in certain domains, such as working memory (Baumgartner et al., 2014; Minear et al., 2013; Uncapher et al., 2016), sustained attention (Fisher et al., 2023; Moisala et al., 2016; Ralph et al., 2014; Rioja et al., 2023; Shin et al., 2024; Yildirim & Dark, 2018), and selective attention (Cain & Mitroff, 2011; Ophir et al., 2009; Wiradhany & Nieuwenstein, 2017).

While these studies have been instrumental in advancing our understanding of the predictors of media multitasking, it should be noted that the observed effects have been small and somewhat inconsistent across studies (Kong et al., 2023; Parry & Le Roux, 2021; Wiradhany & Koerts, 2021; Wiradhany & Nieuwenstein, 2017). A likely explanation for such inconsistencies is that questionnaire measures of media multitasking assess broad media multitasking tendencies without accounting for differences in various situational factors. For instance, while these measures often query the extent to which individuals pair specific forms of media, scores on these measures typically represent aggregate levels of media multitasking across media pairings (e.g., Baumgartner et al., 2017; Ophir et al., 2009). As such, they do not offer insight into differences in the types of media multitasking individuals engage in, which could involve continuously consuming two forms of media (e.g., listening to a podcast while analysing data) or switching between multiple media-based tasks (e.g., responding to text messages while writing emails). Additionally, these measures do not consider whether individuals primarily media multitask in contexts in which this behaviour is unlikely to have negative effects, such as while watching television, or in settings where this

behaviour is often discouraged, such as work meetings. As a result, individuals with similar Media Multitasking Index scores may habitually engage in very different forms of media multitasking. It seems likely that the extent to which individual difference factors predict media multitasking depends on these types of contextual details. Self-control, for example, may negatively predict media multitasking during work meetings, but may be unrelated to media multitasking while watching television. Thus, differences in the contextual factors implicitly captured by questionnaire measures of media multitasking may contribute to the inconsistencies observed across studies. For this reason, it is important to explore not only the individual difference factors that predict general media multitasking tendencies, but also the role of more context-dependent variables that change from one moment to the next and may have more direct effects on this behaviour. These could include affective states that influence one's willingness to attend to a task, or features of one's primary task, such as task difficulty.

An increasingly common approach to studying the antecedents of media multitasking has involved examining this behaviour in more specific contexts than those traditionally assessed by questionnaire measures of media multitasking. Research taking this approach has identified numerous variables, both internal (e.g., personal needs; Wang & Tchernev, 2012) and external (task difficulty; Ralph et al., 2020) to the individual, that may change from one moment to the next and influence media multitasking. For instance, Wang and Tchernev (2012) conducted an experience sampling study in which participants reported their activities, as well as their motives for engaging in them, multiple times daily over the course of several weeks. The authors found that, on a given day, stronger self-reported cognitive and habitual needs, related to strengthening knowledge and engaging in routine behaviours, respectively, predicted greater time spent media multitasking. In the laboratory, Brasel and Gips (2017) explored features that predicted switching between media by

observing participants as they viewed televised content alongside web-based content. The presence of low-level visual cues, such as motion, was found to predict switching whereas higher-level features, such as the presence of people on the screen, promoted a greater maintenance of attention on a single form of media. Along similar lines, Tam and Inzlicht (2024) presented participants with a series of boring videos, as well as a series of interesting videos, to investigate whether boredom encourages switching between media. In line with this view, participants switched more frequently when watching the boring videos compared to the interesting videos. Another paradigm for assessing media multitasking, developed by Ralph and colleagues (2020), involved having participants complete a cognitive task during which they could media multitask by simultaneously playing a video lecture. Variations of this paradigm have been employed across several studies, revealing that low motivation (Ralph et al., 2021), low task difficulty (Ralph et al., 2020), and greater control over the secondary task (Marty-Dugas et al., 2024) lead to higher rates of media multitasking.

A small number of studies have examined media multitasking on a more fine-grained level by tracking how this behaviour unfolds over the course of a primary task. Ragan and colleagues (2014) observed students' laptop use during a three-hour lecture, finding that off-task laptop use varied throughout the lecture, peaking near the start and middle of the lecture, and declining in the later stages. Similarly, Rosen and colleagues (2013) observed participants while they studied over a 15-minute period and found that the percentage of time participants spent engaged in on- versus off-task activities fluctuated over the course of the session. As with the Ragan study, rates of media multitasking were highest near the start and middle of the session and decreased steeply near the end. In contrast to these studies, Wammes and colleagues (2019) found linear increases in media multitasking when asking participants to self-report whether they were media multitasking at several points throughout an 80-minute lecture. Moreover, this behaviour was negatively associated with

students' retention of the lecture content. The patterns of media multitasking observed in these studies likely reflect temporal changes in a variety of factors, such as individuals' interest in the content (Deng et al., 2024) or levels of motivation (Ralph et al., 2021), although this assumption remains to be investigated.

Intriguingly, the temporal increases in media multitasking observed by Wammes and colleagues (2019) closely resemble an important finding within the sustained attention literature. That is, numerous studies have demonstrated that, as time-on-task increases, attention to the task wanes and performance decreases (Brosowsky et al., 2023; Krimsky et al., 2017; Risko et al., 2012; Thomson et al., 2014; Yanko & Spalek, 2014). These declines, referred to as vigilance or sustained attention decrements, have been the subject of considerable debate, with various conflicting theories seeking to account for the phenomenon (e.g., Kurzban et al., 2013; Manly et al., 1999; Thomson et al., 2015). Traditionally, sustained attention decrements have been theorized to arise due to a gradual depletion of the cognitive resources necessary for successful task completion (Davies & Parasuraman, 1982; Greenlee et al., 2024; Helton & Russell, 2011; Ross et al., 2014; Smit et al., 2004; Warm et al., 2008); however, this resource-depletion account may not fully explain sustained attention decrements. From a resource-depletion perspective, media multitasking would be expected to *decrease* over time as the resources available to complete additional tasks diminish. This notion is challenged by studies demonstrating fluctuations (Ragan et al., 2014; Rosen et al., 2013) or increases (Wammes et al., 2019) in media multitasking with time-on-task.

One prominent alternative explanation for sustained attention decrements comes from the opportunity costs account of mental effort (Kurzban et al., 2013). This account holds that the cognitive system prioritizes which tasks to engage in by weighing the costs of persisting with the current task versus the benefits of engaging in alternative activities (i.e., opportunity costs; Kurzban

et al., 2013). Opportunity costs are theorized to increase with time-on-task and may be signaled by states such as fatigue and boredom. Increases in these states are thought to encourage individuals to engage in activities other than the task-at-hand, resulting in performance decrements (Kurzban et al., 2013; Struk et al., 2020). Applying this framework to media multitasking, it is possible that temporal changes in media multitasking reflect varying opportunity costs and are driven by changes in states such as boredom. Exploring this possibility could be instrumental in advancing our understanding of media multitasking and sustained attention more broadly.

In sum, research examining media multitasking in specific contexts (e.g., over specified time periods through experience sampling, Wang & Tchernev, 2012; in the laboratory, Tam & Inzlicht, 2024) has provided evidence that this behaviour is influenced by a variety of factors capable of changing from one moment to the next (e.g., task features; Brasel & Gips, 2017; Marty-Dugas et al., 2024; Ralph et al., 2021). Studies exploring changes in media multitasking over the course of a primary task (Ragan et al., 2014; Rosen et al., 2013; Wammes et al., 2019) also align with this view, as the observed patterns of media multitasking likely reflect temporal variations in certain key variables. However, more research on the temporal dynamics of media multitasking is needed. Notably, few studies have tracked moment-to-moment changes in variables alongside changes in media multitasking over the course of a primary task, which could allow for a more nuanced understanding of how these variables influence media multitasking. Beyond this, studying temporal changes in media multitasking could offer a useful lens through which to examine sustained attention decrements for two key reasons: first, the temporal changes in media multitasking that have been observed thus far (Ragan et al., 2014; Rosen et al., 2013; Wammes et al., 2019) conflict with a major class of accounts for sustained attention decrements (i.e., resource-depletion accounts; Davies & Parasuraman, 1982; Greenlee et al., 2024; Helton & Russell, 2011; Ross et al., 2014; Smit et al., 2004;

Warm et al., 2008). Second, media multitasking can serve as a clear and objective indicator of shifts in attention, as opposed to self-report measures (e.g., thought probes; Brosowsky et al., 2023; Krimsky et al., 2017; Risko et al., 2012; Thomson et al., 2014; Yanko & Spalek, 2014) or methods that infer attention from task performance (e.g., Grier et al., 2003; Helton et al., 2005; Manly et al., 1999).

Considering the media multitasking literature as a whole, it appears that individual difference factors broadly predict media multitasking, but whether and how these behaviours manifest may additionally depend on specific state-level or contextual factors. This view implies that media multitasking results from an interplay between stable trait-like factors and moment-to-moment changes in variables with more immediate effects on media multitasking, with the influence of stable factors varying based on the presence of certain contextual or state-level factors. Studying media multitasking from this perspective could help bridge the two major areas of research on the topic, which have largely examined the role of individual difference and more context-dependent variables in this behaviour separately. In bridging these areas, this approach could also improve researchers' ability to predict media multitasking. Despite these benefits, few studies have explicitly considered the joint influence of trait- and state-like factors in predicting media multitasking, making it another important area for further research.

The Present Investigations

The purpose of the current thesis was to offer a more comprehensive understanding of the drivers of media multitasking by addressing the gaps in the literature that have been highlighted above. The studies presented in this dissertation primarily focused on elucidating how specific factors (Chapters 2 and 3), or interactions amongst factors (Chapters 4 and 5), predict the extent of individuals' media multitasking at a given moment in time. They therefore specifically examined in-

the-moment instances of this behaviour, which were captured using Ralph and colleagues' (2020) media multitasking paradigm. In this paradigm, participants completed a cognitive (*n*-back; Kirchner, 1958) task while given the option to media multitask by simultaneously playing a task-irrelevant video. Participants could turn the video on or off at their discretion by pressing a key, and each trial spent with the video turned on was considered a media multitasking trial. This method allowed for the quantification of aggregate levels of media multitasking by summing the total number of trails spent with the video on, as well as the examination of changes in media multitasking over time by segmenting the trials into blocks.

Chapters 2 and 3 investigate the understudied temporal dynamics of media multitasking, providing greater insight into how changes in certain variables (e.g., state boredom) might influence patterns of media multitasking over the course of a primary task. The study presented in Chapter 2 viewed temporal increases in media multitasking as modern manifestations of sustained attention decrements and considered this behaviour from an opportunity costs perspective (Kurzban et al., 2013), with state boredom being the main variable hypothesized to play a role in this behaviour. Chapter 3 consists of two studies that built upon this work by exploring whether increasing one's motivation to complete a primary task, which should decrease the perceived opportunity costs of engaging in the task, attenuates temporal increases in media multitasking. The first study re-analyzed data from Ralph and colleagues (2021), who demonstrated that increasing motivation decreased aggregate levels of media multitasking. The aim here was to understand how the effect of increasing motivation on media multitasking unfolds over time. The second study extended this work by assessing how changes in motivation and media multitasking varied over time as a function of the motivation manipulation. The studies presented in Chapter 3 provided evidence for motivation as an additional factor that influences media multitasking.

The work described in Chapters 4 and 5 considered the interplay between individual differences and contextual factors in predicting media multitasking. Since prior research has noted relations between questionnaire measures of media multitasking and traits indicative of poor sustained attention (e.g., tendencies towards attentional lapses, mind-wandering, and attention-related cognitive errors; Ralph et al., 2014; Sansevere & Ward, 2021), these traits were included as possible predictors of media multitasking. This work also considered the role of several self-regulatory traits. Specifically, low conscientiousness (Ma et al., 2024; Toyama & Hayashi, 2022, 2023), low self-control (Błachnio et al., 2023; Luo et al., 2024; Minear et al., 2013; Xu et al., 2016) and high trait boredom proneness (Mayl et al., 2023; Tam & Inzlicht, 2024), characterized by a tendency to experience boredom frequently and intensely (Tam et al., 2021), were examined in relation to media multitasking. Additionally, as few studies have examined whether commonly employed questionnaire measures of media multitasking predict in-the-moment instances of this behaviour, Chapters 4 and 5 took the opportunity to explore whether scores on the Media Multitasking Index (Ophir et al., 2009) and Short Media Multitasking Measure (Baumgartner et al., 2017) relate to in-study media multitasking.

The study reported in Chapter 4 investigated whether tendencies towards inattention and traits indicative of low self-regulation predicted greater in-the-moment instances of media multitasking. It further investigated whether the relations between these factors and media multitasking varied as a function of a contextual variable known to influence media multitasking: task difficulty (Ralph et al., 2020). The study described in Chapter 5 examined the reliability of participants' media multitasking behaviours across two sessions, spaced approximately one week apart. It additionally assessed the relations between media multitasking and the aforementioned individual difference factors. The assumption underlying this study was that, if general media

multitasking tendencies are driven by stable individual difference factors, individuals should show consistent patterns of media multitasking when key contextual variables are held constant (e.g., environment, task type, opportunities to media multitask). Moreover, these patterns should be predicted by stable individual difference factors.

Chapter 6 summarizes the findings of the thesis and contextualizes them within the current media multitasking literature. Drawing on prior work, as well as the studies presented here, this chapter additionally proposes a novel framework for understanding media multitasking. The proposed model categorizes the predictors of media multitasking into five components – cognitive architectural, dispositional, metacognitive, task valuative and environmental – with the influence of factors within each component existing on a spectrum. On one end of the spectrum are stable, trait-like factors that are relatively resistant to change over time (e.g., individual difference factors), and on the other end are transient, state-like factors that may vary from one moment to the next (e.g., motivational states, one's environment). The cognitive architectural and dispositional components reflect primarily stable influences, with the former referring to neural and cognitive features that influence how individuals process information (e.g., their ability to simultaneously attend to multiple tasks) and the latter encompassing traits and personality characteristics that determine one's proneness towards media multitasking (e.g., boredom proneness). The metacognitive and task valuative components reflect both stable and transient influences. The metacognitive component concerns one's awareness of their ability to media multitask and the consequences of engaging in this behaviour, while the task valuative component consists of factors that influence how much one values their current task versus media multitasking (e.g., their motivation to complete a primary task). Finally, the environmental component involves predominantly transient influences within one's current environment, such as the tasks available to them or the social acceptability of media

multitasking in a given setting. The chapter explains how these components interact to determine one's likelihood of media multitasking at any given moment.

Chapter 2: Do risindong opportunity costs lead to increases in media multitasking over time?[1]

2.1 Introduction

A prominent class of theories on sustained attention decrements holds that the cognitive resources required to effectively attend to a task diminish with time-on-task, leading to gradual declines in attention and performance (resource-depletion accounts; Greenlee et al., 2024; Helton & Russell, 2011; Smit et al., 2004). By this account, individuals should become less likely to take on additional tasks (e.g., via media multitasking) as their cognitive resources diminish; however, this view is challenged by studies demonstrating fluctuations (Ragan et al., 2014; Rosen et al., 2013) and linear increases (Wammes et al., 2019) in media multitasking over the course of tasks requiring sustained attention. An alternative explanation comes from the opportunity costs account of mental effort (Kurzban et al., 2013), which posits that individuals are continually monitoring opportunity costs – that is, the benefits of persisting with their current activity versus the potential benefits of engaging in other tasks. Feelings of boredom (Struk et al., 2020) and a perception that the current task is effortful are thought to signal rising opportunity costs, thereby motivating individuals to engage their effort elsewhere (Kurzban et al., 2013). This shift in focus away from one's current task and towards other activities is thought to cause gradual degradations in attention and task performance (Kurzban et al., 2013).

Critically, the opportunity costs account may explain the temporal variations in media multitasking that have been observed in the literature. That is, individuals may multitask to alleviate the negative states that accompany rising opportunity costs, such as boredom or the perceived

[1] This chapter is based on work previously published in: Drody, A. C., Ralph, B. C., Danckert, J., & Smilek, D. (2024). Do rising opportunity costs lead to increases in media multitasking over time?. *Media Psychology*, *27*(1), 135-160. https://doi.org/10.1080/15213269.2023.2227562

effortfulness of their current task. Opportunity costs are generally theorized to increase with time-on-task, as prolonged task completion typically offers diminishing returns (Kurzban et al., 2013), which would explain the previously observed temporal increases in media multitasking (Wammes et al., 2019). However, there may be instances in which opportunity costs vary more dynamically over time. For instance, the value one assigns to attending a lecture versus engaging in other activities may vary from one moment to the next depending on numerous factors, such as one's interest in the content or the likelihood that the material will appear on a future test. Such fluctuations in opportunity costs may underly some of the more complex patterns of media multitasking reported in the literature (Ragan et al., 2014; Rosen et al., 2013).

The present study examined media multitasking from an opportunity costs perspective. Specifically, it explored whether changes in media multitasking (as well as state boredom, effort and performance, all variables relevant to the opportunity costs account) over the course of a sustained attention task aligned with the patterns that would be expected from an opportunity costs perspective. Importantly, effort was measured in terms of the amount participants reported devoting to performing well on the primary task rather than the perceived effortfulness of the task itself. This distinction is crucial, as one might expect different outcomes when observing changes in these two types of effort ratings over time. According to the opportunity costs account, individuals should find remaining attentive to their primary task *increasingly* effortful as the opportunity costs of completing the task increase over time. At the same time, this account predicts that rising feelings of boredom and increases in the perceived effortfulness of the task should lead individuals to engage in activities other than the primary task, resulting in a progressive *decrease* in the amount of effort they report devoting to performing well on the task.

Changes in the above-mentioned variables (i.e., media multitasking, boredom, effort and performance) were observed in the context of a 1-back task, as this task has previously been used in studies of media multitasking (Drody et al., 2022; Ralph et al., 2019, 2020, 2021). The monotonous nature of this task was expected to promote steady increases in perceived opportunity costs over time rather than more variable patterns that could occur in response to content or feature changes in other tasks (e.g., live lectures), allowing for more straightforward predictions. Participants completed the 1-back in one of two conditions. In the Choice condition, they were given the opportunity to respond to rising opportunity costs by playing a task-irrelevant video during the task (i.e., media multitasking) using a method previously employed by Ralph and colleagues (2020). In the No-Choice condition, participants were not given this option and instead completed the 1-back as a single task. This meant that media multitasking could only be assessed in the Choice condition and not in the No-Choice condition. In contrast, the other variables of interest were assessed in both conditions. An advantage of this approach is that it allowed for a comparison of changes in these variables over time when media multitasking was an option versus when it was not.

As per the opportunity costs account, several general trends were hypothesized. Specifically, media multitasking in the Choice condition was expected to increase with time-on-task. Additionally, regardless of condition, ratings of state boredom were hypothesized to increase with time-on-task, while the amount of effort participants reported deploying to the task and task performance were expected to decrease. Several differences across the Choice and No-Choice conditions were also anticipated. It was expected that boredom would be higher or increase more sharply in the No-Choice relative to the Choice condition, as participants in the Choice condition could attempt to alleviate boredom by playing the optional video. It was also hypothesized that the amount of effort participants reported deploying to the task would decrease more sharply in the Choice condition

relative to the No-Choice condition, as an increasing tendency to engage with the video among participants in the Choice condition should lead to a gradual diversion of effort away from the primary task. Finally, task performance was predicted to decrease more steeply in the Choice condition compared to the No-Choice condition. The rationale for this hypothesis was that participants in the Choice condition should become more likely to attend to the optional video over time, which should detract from performance on the 1-back.

2.2 Methods

2.2.1 Participants

A total of 302 undergraduate students (218 female, 81 male, 3 unknown) with an age range of 16 to 58 years old (M_{age} = 19.86, SD_{age} = 3.20) were recruited from an online human participant pool (SONA) at the University of Waterloo and participated in exchange for course credit. Participants completed the experiment online and accessed it through a link provided on SONA. The experiment program randomly assigned participants to each condition, which resulted in slightly uneven group sizes. There were 148 participants in the Choice condition and 154 participants in the No-Choice condition. All participants provided informed consent prior to taking part in the experiment.

2.2.2 Materials

2.2.2.1 1-back Task

The experiment was programmed using custom-built HTML, Javascript, CSS and PhP code. The 1-back consisted of 486 trials, 18 of which were practice trials that were removed prior to analysis of the data. On each trial of the 1-back, a black letter (B, F, K, H, M, Q, R, X or Z) appeared in the center of the screen against a light grey background for 500 ms. A fixation cross appeared for 2000 ms after each letter. Participants were instructed to press the spacebar when the

current letter matched the letter presented in the previous trial. The experimental trials contained 78 target trials and 390 non-target trials. Target trials were randomly distributed throughout the task, with the constraint that a target trial could not appear in sequence with another target trial (i.e., the same letter could not appear on three trials in a row). Performance measures on the 1-back consisted of proportion of hits (i.e., the proportion of responses to target trials) and proportion of false alarms (i.e., the proportion of responses to non-target trials).

2.2.2.2 Thought Probes

While completing the 1-back, participants were interrupted on nine occasions and prompted to respond to thought probes assessing their levels of state boredom and deployed effort just prior to the appearance of the probes. The boredom probes asked participants to respond to the question "How bored do you feel right now?", using a slider ranging from 1 (not bored at all) to 100 (very bored). The effort probes asked participants, "How much effort were you exerting to perform well on this task?". Participants also responded to the effort probes using a slider ranging from 1 (no effort at all) to 100 (a lot of effort). Probes were presented pseudo-randomly and set to occur once within sets of 52 trials. The minimum number of trials between probes in this sample was three, and the maximum was 100. On average, probes were spaced 49.88 trials apart (SD = 21.93). Importantly, the average number of trials between probes did not differ between those in the Choice (M = 48.45, SD = 23.34) or No-Choice (M = 51.11, SD = 20.73) conditions, $t(132) = -0.70$, $p = .486$.

2.2.2.3 Media Multitasking

Using a similar paradigm to that of Ralph and colleagues (2020), prior to completing the 1-back, participants in the Choice condition were informed that they would be able to play an optional, task-irrelevant video lecture while performing the task. The video was a TED talk by Keith Barry entitled "Brain Magic". The length of the video was made to correspond to the length of the

1-back (approximately 20-minutes), and participants could turn the video on or off at any point during the task by pressing the 't' key. If played, the video appeared in the center of the screen directly above the 1-back stimuli (Figure 2.1).



Figure 2.1. Image of the 1-back in the Choice condition when the video was turned on (left) and when the video was turned off or unavailable (i.e., in the No-Choice condition; right).

If participants switched the video off and then on again, the video would play from where it left off. Each trial spent with the video on was counted as an instance of media multitasking. Participants in the Choice condition received the following instructions regarding the video, which were based on the instructions used by Ralph and colleagues (2020):

> "While you complete the 1-back, you will also have the opportunity to watch a video. There will be no test on the content of this video, and you are not required to watch it. However, you may watch the video while you do the 1-back, if you wish. The video will be turned off once you begin the task, but you may toggle the video on and off at your leisure, throughout the task, using the 't' key (remember t for Toggle)."

Participants in the No-Choice condition did not receive instructions regarding the video.

2.2.2.4 Post-Task Questions

The online design of this study raised the possibility that participants might have engaged in activities unrelated to the experiment while participating in the study. To assess whether this was the case and remove inattentive participants, the following question and response options (previously employed by Drody et al., 2022) were presented immediately after participants completed the 1-back:

> "While completing this study, were you engaged in any media-related activities outside of the contents of the experiment (e.g., attending to content in another browser, listening to music or using a smartphone/tablet while completing the study)?
>
> Yes.
>
> No, but I was engaged in other media-unrelated activities while completing this study.
>
> No, I didn't engage in any activities outside of the contents of this study."

Additionally, to detect and remove participants who did not understand the task instructions, participants in the Choice condition were asked to respond "Yes" or "No" to the question, "Were you aware that you could turn an optional video on or off during the experiment by pressing the 't' key?". Finally, participants in the Choice condition were asked "Have you seen the video presented during experimental task (the 1-back) before?" and could respond either "Yes" or "No" (Ralph et al., 2021). Because only 0.02% of participants in the Choice condition reported having previously seen the video, responses to the question assessing participants' familiarity with the video are not included in any further analyses.

2.2.2.5 Trait Boredom Proneness

Although explorations of boredom in the present study were primarily concerned with state boredom rather than trait boredom proneness – that is, the tendency to experience boredom frequently and intensely (Tam et al., 2021), the Short Boredom Proneness Scale (Struk et al., 2017) was employed to explore a potential relation between this trait and media multitasking. The Short Boredom Proneness Scale asks participants to rate the extent to which they agree with eight questions (e.g., "I find it hard to entertain myself") using a Likert scale with response options ranging from 1 (strongly disagree) to 7 (strongly agree). Scores are calculated by summing participants' responses across each item. Thus, higher scores indicate higher levels of trait boredom proneness. This scale has demonstrated good internal consistency in prior work (α = .88; Struk et al., 2017) and showed good internal consistency in the current study (α = .87).

2.2.3 Procedure

After providing informed consent, participants completed the Short Boredom Proneness Scale and were then randomly assigned to the Choice or No-Choice conditions. Participants subsequently received instructions regarding the 1-back task and, for those in the Choice condition, how to toggle the optional video. After completing the 1-back task, participants responded to the post-task questions.

2.3 Results

2.3.1 Data Preprocessing

Prior to analyzing the data for this experiment, 135 participants who indicated having engaged in activities outside the experimental context were removed. Responses to the question assessing participants' awareness that they could toggle the video were also examined. Fifty-four participants reported being unaware that they could toggle the video; however, because some of

these participants were already removed based on their responses to the question assessing media multitasking with content outside the experimental context, this only resulted in the removal of an additional 25 participants. Finally, to remain consistent with a prior media multitasking study that employed similar methods (Ralph et al., 2021), participants with hit rates under 30% and false alarms over 20% were removed. The rationale behind removing particularly poor performers is that extremely low performance on the 1-back may be indicative of a failure to understand task instructions or an unwillingness to follow them. The final sample used in data analysis consisted of 134 participants (37 male, 97 female) with an age range of 17 to 29 years old (M_{age} = 19.71, SD_{age} = 2.03). There were 62 participants in the Choice condition and 72 participants in the No-Choice condition.

2.3.2 Data Analysis Overview

The first analysis evaluated whether media multitasking increased over the course of the 1-back by quantifying the percentage of participants in the Choice condition who media multitasked with the video for each trial of the 1-back. To explore a potential relation between boredom proneness and media multitasking, scores on the Short Boredom Proneness Scale were then correlated with the total number of trials participants spent media multitasking. Next, changes in participants' ratings of state boredom and effort were examined as a function of Choice condition. To explore these differences, participants' responses to the boredom and effort probes were submitted to two separate mixed factorial ANOVAs with choice condition (Choice or No-Choice) as a between-participants factor and probe position (the nine probes presented throughout the 1-back) as a within-participants factor. In all cases, where Mauchly's assumption of sphericity was violated, a Greenhouse-Geisser correction was applied to the degrees of freedom. Finally, changes in participants' performance over the course of the 1-back were analyzed by dividing trial data on the

1-back into nine blocks of 52 trials to correspond to the nine windows in which the boredom and effort probes appeared. Performance measures (i.e., proportion of hits and proportion of false alarms) were then calculated for each block and submitted to three separate mixed factorial analyses of variance (ANOVAs) with choice condition as a between-participants factor and block (the nine blocks of the 1-back) as a within-participants factor.

2.3.3 Media Multitasking

In all, 59.68% of participants in the Choice condition played the optional video on at least one trial of the 1-back. As shown in Figure 2.2A, participants became more likely to media multitask as time on task increased, with 17.74% of participants in the Choice condition playing the video at the start of the task and 37.10% of participants playing the video by the end of the task. On average, participants played the video for 115 trials (*Mdn* = 4.50, skew = 1.11, kurtosis = -0.48). Due to the skewed nature of the media multitasking data, a Spearman rank-order correlation was employed to investigate the relation between trait boredom proneness and media multitasking. No significant relation was observed, $r_s(60) = -.15$, $p = .239$.

2.3.4 State Boredom

Mean ratings of state boredom as a function of probe position are shown in Figure 2.2B. There was a significant main effect of condition, $F(1, 132) = 7.74$, $p = .006$, $\eta_p^2 = .06$, such that those in the Choice condition experienced less boredom relative to those in the No-Choice condition. There was also a main effect of probe position, $F(2.86, 377.12) = 65.20$, $p < .001$, $\eta_p^2 = .33$, with boredom increasing steadily over time. No interaction was found between condition and probe position, $F(2.86, 377.12) = 1.54$, $p = .207$, $\eta_p^2 = .01$.

2.3.5 Effort

Mean ratings of effort based on probe position are illustrated in Figure 2.2C. There was no main effect of condition, $F(1, 132) = 0.05$, $p = .817$, $\eta_p^2 < .01$; however there was a significant main effect of probe position, $F(3.75, 471.52) = 25.15$, $p < .001$, $\eta_p^2 = .16$, as well as a significant interaction between condition and probe position, $F(3.75, 471.52) = 2.70$, $p = .036$, $\eta_p^2 = .02$. Participants in the Choice condition experienced a shallower decrease in effort over time compared to those in the No-Choice condition.

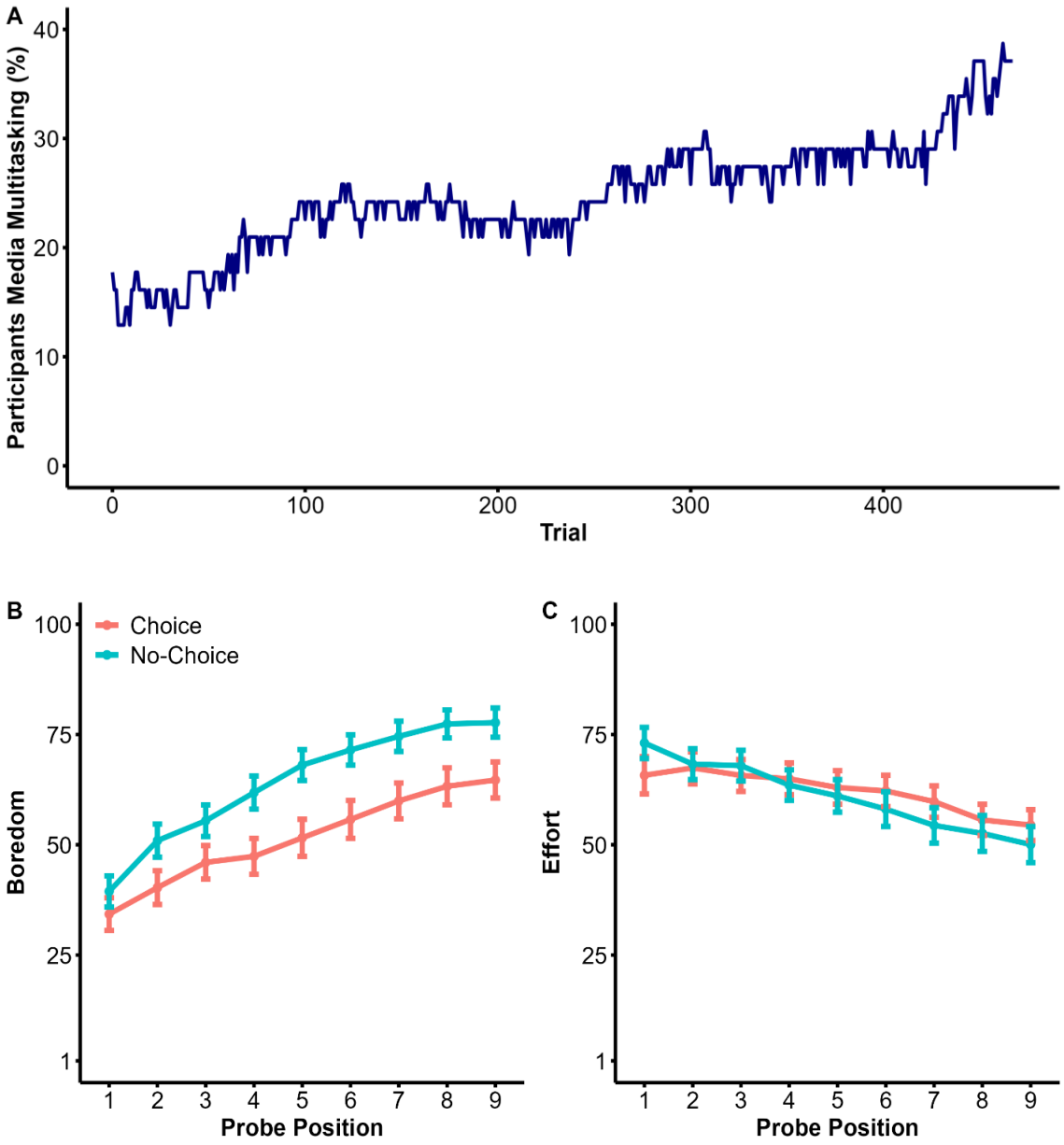


Figure 2.2. (A) Line graph depicting the percentage of participants who played the video (i.e., media multitasked) on each trial of the 1-back. (B) Mean (±SE) ratings of state boredom as a function of probe position and Choice condition. (C) Mean (±SE) ratings of effort as a function of probe position and Choice condition.

2.3.6 1-back Performance

2.3.6.1 Proportion of Hits

Proportions of hits for each block of the 1-back are presented in Figure 2.3A. There was no main effect of condition, $F(1, 132) = 0.30$, $p = .588$, $\eta_p^2 < .01$. There was, however, a significant main effect of block, $F(5.27, 695.18) = 14.78$, $p < .001$, $\eta_p^2 = .10$, such that proportion of hits decreased over time. No significant interaction was observed between condition and block, $F(5.27, 695.18) = 1.71$, $p = .126$, $\eta_p^2 = .01$.

2.3.6.2 Proportion of False Alarms

Proportion of false alarms for participants in each condition are presented in Figure 2.3B. There were no main effects of condition, $F(1, 132) = 0.51$, $p = .477$, $\eta_p^2 < .01$, or block, $F(3.69, 487.01) = 1.81$, $p = .131$, $\eta_p^2 = .01$, and there was no significant interaction between condition and block, $F(3.69, 487.01) = 1.66$, $p = .163$, $\eta_p^2 = .01$.

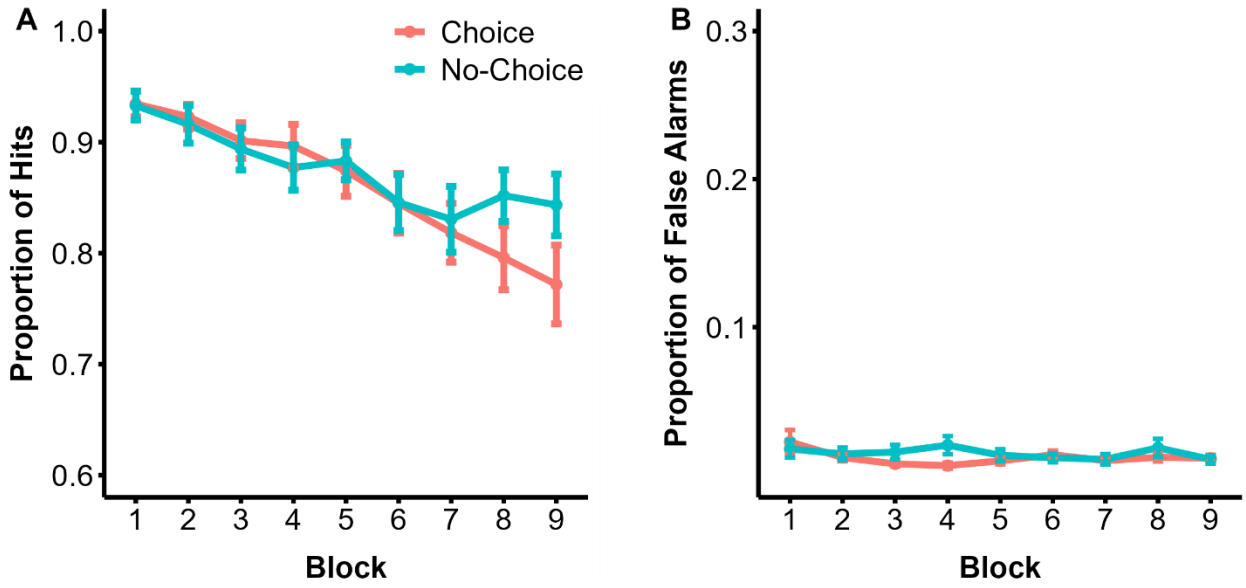


Figure 2.3. (A) Graph showing mean (±SE) proportion of hits for participants in the Choice and No-Choice conditions for each block of the 1-back. (B) Mean (±SE) proportion of false alarms as a function of block and Choice condition.

2.3.7 Exploratory Analyses

Recall that analysis of responses to the post-task question revealed that nearly half of the initial sample reported having engaged in tasks unrelated to the experiment while completing the study. This finding offered a unique opportunity to study real-world, ecologically valid, instances of media multitasking and their relation to subjective ratings of state boredom and effort, as well as task performance. The following analyses investigated changes in these variables over time based on whether participants engaged in more naturally occurring, unspecified forms of media multitasking while completing the experiment (i.e., whether they indicated that they were completing media-related tasks alongside the experiment; Extra-Experimental MMT condition; n = 94), or whether they did not media multitask during the study, either by playing the task-irrelevant video or by engaging in tasks unrelated to the experiment (No MMT condition; n = 167). Importantly, this grouping was independent of the conditions (i.e., Choice vs. No-Choice) to which participants were originally assigned.

2.3.7.1 Data Preprocessing

For the sake of consistency, the same performance filters applied to the dataset used for the main analyses (i.e., hit rates over 30% and false alarm rates under 20%) were applied to the present dataset. After removing participants with particularly poor performance on the 1-back, 71 participants remained in the Extra-Experimental MMT condition, and 142 participants remained in the No MMT condition.

2.3.7.2 Extra-Experimental Media Multitasking and Boredom

Mean ratings of state boredom for those in the Extra-Experimental MMT and No MMT conditions are shown in Figure 2.4A. Results of a mixed factorial ANOVA with condition (Extra-Experimental MMT or No MMT) as a between-participants factor and probe position as a within-

participants factor indicated that there was a significant main effect of condition, $F(1, 211) = 9.90$, $p = .002$, $\eta_p^2 = .05$, such that those in the Extra-Experimental MMT condition reported higher levels of boredom compared to those in the No MMT condition. There was also a main effect of probe position, $F(3.52, 741.68) = 86.32$, $p < .001$, $\eta_p^2 = .29$, with boredom increasing steadily over time. There was no interaction between condition and probe position, $F(3.52, 741.68) = 0.89$, $p = .459$, $\eta_p^2 = .00$.

Levels of trait boredom proneness were also compared between those who did and did not report engaging in extra-experimental media multitasking. Scores for one participant, who did not respond to all items on the Short Boredom Proneness Scale, are not included in the present analysis. Results of an independent-samples *t*-test revealed that trait boredom proneness scores did not differ between those in the Extra-Experimental MMT ($M = 29.65$, $SD = 9.61$) and No MMT conditions ($M = 27.50$, $SD = 9.11$), $t(210) = 1.59$, $p = .114$, $d = .23$.

2.3.7.3 Extra-Experimental Media Multitasking and Effort

Mean ratings of effort for those in the Extra-Experimental MMT and No MMT groups are shown in Figure 2.4B. Responses to the effort probes were entered into a mixed factorial ANOVA with condition as a between-participants factor and probe position as a within-participants factor. There was a main effect of condition, $F(1, 211) = 4.92$, $p = .028$, $\eta_p^2 = .02$, as well as a main effect of probe position, $F(3.76, 793.76) = 68.55$, $p < .001$, $\eta_p^2 = .25$. There was also a significant interaction between condition and probe position, $F(3.76, 793.76) = 3.30$, $p = .012$, $\eta_p^2 = .02$. Multiple comparisons adjusted using Tukey's HSD revealed that, relative to those in the No MMT condition, participants in the Extra-Experimental MMT condition reported expending less effort from the fifth probe until the end of the task ($ps < .05$).

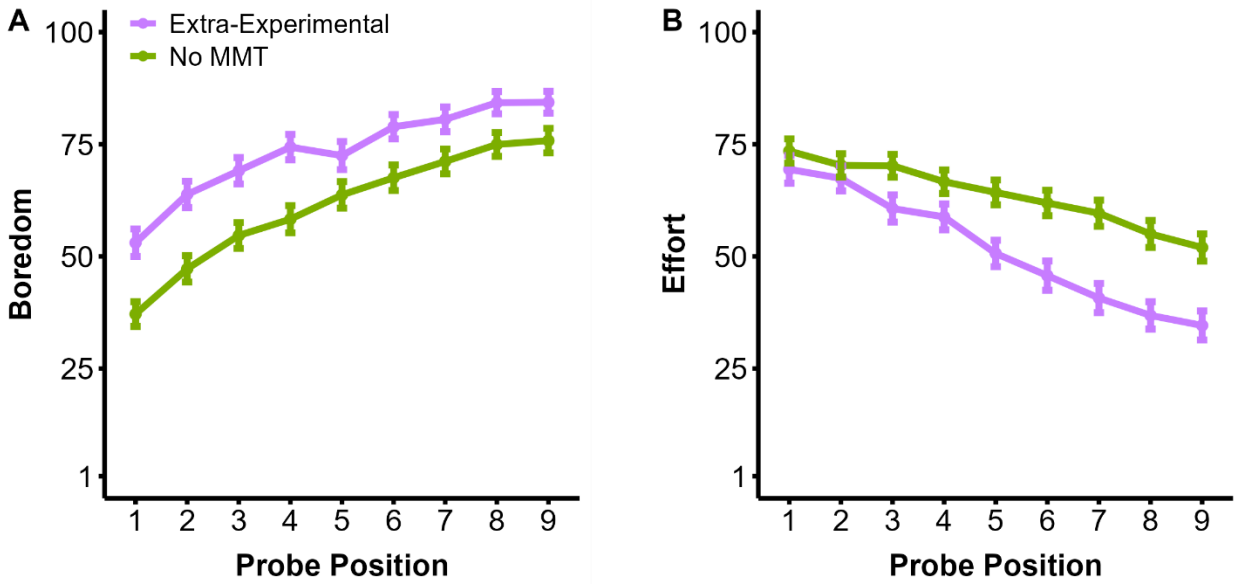


Figure 2.4. Mean (±SE) ratings of (A) state boredom and (B) effort for participants in the Extra-Experimental MMT and No MMT conditions as a function of probe position.

2.3.7.4 Extra-Experimental Media Multitasking and Proportion of Hits

Proportion of hits for those in the Extra-Experimental MMT and No MMT conditions are presented in Figure 2.5A. Proportion of hits were submitted to a mixed factorial ANOVA with condition as a between-participants factor and block as a within-participants factor. Results revealed a significant main effect of condition, $F(1, 211) = 11.47$, $p < .001$, $\eta_p^2 = .05$, a main effect of probe position, $F(5.33, 1124.57) = 43.91$, $p < .001$, $\eta_p^2 = .17$, and a significant interaction between condition and block, $F(5.33, 1124.57) = 6.93$, $p < .001$, $\eta_p^2 = .03$. Multiple comparisons adjusted using Tukey's HSD indicated that, compared to those in the No MMT condition, proportion of hits were significantly lower among those in the Extra-Experimental MMT condition from the fourth block until the end of the task ($ps < .05$).

2.3.7.5 Extra-Experimental Media Multitasking and Proportion of False Alarms

Proportion of false alarms for those in the Extra-Experimental MMT and No MMT conditions can be found in Figure 2.5B. Results of a mixed factorial ANOVA with condition as a between-participants factor and block as a within-participants factor revealed that there were no main effects of condition, $F(1, 211) = 0.84$, $p = .362$, $\eta_p^2 = .00$, or block, $F(3.46, 730.82) = 2.29$, $p = .068$, $\eta_p^2 = .01$. Further, there was no interaction between condition and block, $F(3.46, 730.82) = 0.58$, $p = .650$, $\eta_p^2 = .00$.

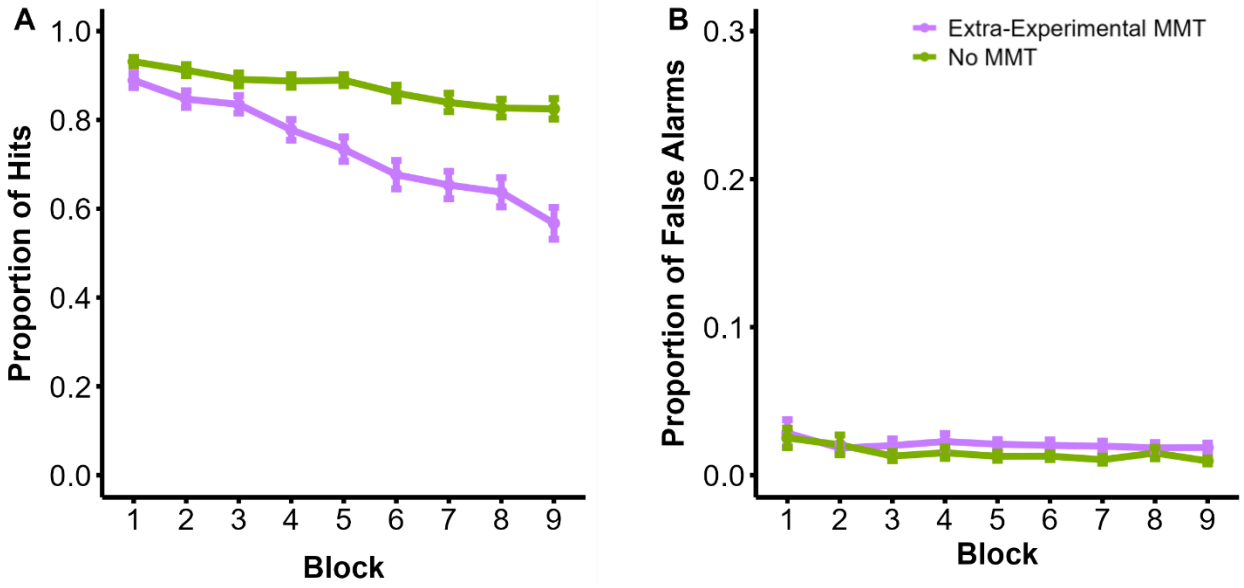


Figure 2.5. Graph showing (A) mean (±SE) proportion of hits for participants in the Extra-Experimental MMT and No MMT conditions for each block of the 1-back. (B) Mean (±SE) proportion of false alarms for participants in the Extra-Experimental MMT and No MMT conditions for each block of the 1-back.

2.4 Discussion

The observed patterns of media multitasking, state boredom, effort and performance largely aligned with the predictions of the opportunity costs account. That is, media multitasking and state boredom both increased, while effort decreased over the course of the 1-back task. Additionally, and congruous with prior findings (e.g., Grier et al., 2003; Pattyn et al., 2008; Warm et al., 2008), there

was a decrement in performance over time, with proportion of hits decreasing over successive blocks of the task. The only performance measure that did not show a decrement over time was false alarms; however, given that the proportion of false alarms was extremely low and the proportion of hits remained relatively high in both conditions, this finding can likely be attributed to the task being too easy, leading to floor effects for false alarms. When examining differences across Choice conditions, state boredom was found to be lower in the Choice relative to the No-Choice condition. This finding aligns with the predictions of the opportunity costs account as well as prior work (Struk et al., 2020; Tam & Inzlicht, 2024) by showing that individuals are more bored under conditions in which they are not given the option to alleviate the negative feelings that accompany rising opportunity costs.

When observing changes in effort as a function of the Choice condition however, results ran contrary to hypotheses. Although the difference across conditions was small, self-reported effort devoted to the task declined more rapidly among those in the No-Choice condition compared to those in the Choice condition. It is possible that this unanticipated finding arose due to differences in each group's experience of the 1-back task. That is, because participants in the No-Choice condition reported experiencing higher levels of state boredom than those in the Choice condition, they may have felt less inclined to devote effort to the task and therefore exhibited steeper decreases in effort over time. Another possibility is that both groups diverted similar levels of effort away from the 1-back task but did so in different ways. In the No-Choice condition, this diversion of effort may have occurred primarily through extra-experimental media multitasking, whereas in the Choice condition, it may have involved a mixture of playing the optional video and engaging in other media-related activities. Another surprising outcome in the present study was that 1-back performance did not differ as a function of group. There may be a number of explanations for this

unexpected result. First, as previously alluded to, the low proportion of false alarms and high proportion of hits throughout the 1-back task suggest that the task itself may have been too easy. Second, rates of media multitasking during the experiment were low among those in the Choice condition and may not have been sufficient to affect performance on the 1-back. Both factors could have prevented the detection of any group differences in performance.

Patterns of effort and performance more closely aligned with the hypotheses when examining exploratory analyses comparing participants who engaged in extra-experimental media multitasking to those who refrained from multitasking of any kind. Compared to those in the No MMT condition, participants in the Extra-Experimental MMT condition reported lower levels of effort which decreased more steeply over time. In terms of performance, they also showed sharper declines in proportion of hits over time, suggesting that engagement in this more personally relevant form of media multitasking led to substantial performance costs. These findings provide evidence for the notion that, as the opportunity costs of completing a task increase over time, attention begins to shift toward alternative activities, leading to a withdrawal of effort from the task and reduced task performance. Further consistent with this opportunity cost perspective, participants in the Extra-Experimental MMT condition reported higher levels of boredom throughout the 1-back task, suggesting that extra-experimental media multitasking may have been driven, at least in part, by heightened state boredom.

In sum, the patterns of media multitasking, state boredom, effort and performance in the present study largely support the view that rising opportunity costs drive increases in media multitasking over time, although further research may be necessary to clarify the factors underlying the observed patterns of effort. Findings from this study also contribute to the growing body of work highlighting the prevalence of off-task activities during online studies (Drody et al., 2023;

Necka et al., 2016; Zwarun & Hall, 2014) and emphasize the importance of examining or accounting for these behaviours when conducting research online. Indeed, responses on the self-report measures, as well as task performance, differed based on whether participants engaged in extra-experimental media multitasking. Interestingly, the observed differences continued to align with outcomes that might be expected from an opportunity costs perspective.

Chapter 3: Inattention over time-on-task: The role of motivation in mitigating temporal increases in media multitasking[2]

3.1 Introduction

The studies presented in the current chapter aimed to extend the work presented in Chapter 2 by exploring whether manipulating a variable relevant to the opportunity costs account mitigates temporal increases in media multitasking. The variable of interest was motivation, as manipulating motivation should directly affect the value individuals assign to attending to their current task versus alternative tasks. Ralph and colleagues (2021) previously examined the influence of motivation on media multitasking by having participants complete the 1-back media multitasking paradigm in one of two conditions: one in which they received standard task instructions and another in which they received motivating instructions informing them that they could leave the experimental session early if they performed sufficiently well on the task. The authors found that participants who received the motivating instructions media multitasked significantly less than those given standard instructions. These results suggest that increasing individuals' motivation to perform well on a primary task reduces rates of media multitasking; however, no studies have examined how the effect of increasing motivation on media multitasking unfolds over time.

Exploring this issue is necessary when approaching media multitasking from an opportunity costs perspective (Kurzban et al., 2013), as this account largely makes predictions about changes that occur with time-on-task. Moreover, manipulating motivation could influence how media multitasking evolves over time in a variety of possible ways. From an opportunity costs perspective, increasing motivation might be expected to slow or even eliminate the increases in media

[2] The work presented in this chapter is based on research previously published in: Drody, A. C., Pereira, E. J., Danckert, J., & Smilek, D. (2025). Inattention over time-on-task: The role of motivation in mitigating temporal increases in media multitasking. *Frontiers in Cognition*, *4*, 1547295.

multitasking and accompanying decreases in performance that occur over time, presumably in response to rising opportunity costs. However, other outcomes are possible. For example, manipulating motivation might only lead to short-lived effects on media multitasking, consistent with prior work demonstrating that the effects of mood inductions often do not persist for longer than approximately 5 minutes (Drody et al., 2022; Gillies & Dozois, 2021; Hunter & Eastwood, 2018; Kuijsters et al., 2016; Monno et al., 2024). This could lead to differences in aggregate levels of media multitasking between groups but may call into question the utility of such interventions. These different possible outcomes highlight the importance of examining how increasing motivation influences changes in media multitasking over time beyond only examining its effect on aggregate levels of media multitasking.

The first study presented in this chapter reanalyzed data from Ralph and colleagues' (2021) Experiment 1 to elucidate how increasing motivation influenced participants' media multitasking behaviours over the course of an experiment. The second study employed the same motivation manipulation but extended this work by incorporating thought probes to assess motivation throughout the primary task. If motivation and media multitasking co-vary over time, this would provide further support for a role of motivation in media multitasking.

Certain general trends were expected in the present studies. First, it was hypothesized that media multitasking would increase, and that performance would decline, with time-on-task in both studies. Additionally, it was anticipated that motivation would decrease over the course of the task in Study 3.2. Differences between the groups who received standard versus motivating task instructions were also hypothesized. Specifically, participants who received the motivating instructions were expected to begin the task with higher levels of motivation and experience more gradual declines in motivation over time compared to those who received the standard instructions.

It was further anticipated that participants who received the motivating instructions would show more gradual increases in media multitasking as well as more gradual decreases in task performance over time compared to those who received the standard instructions.

3.3 Study 3.1

This study re-analyzed data from Ralph and colleagues' (2021) Experiment 1 to investigate how increasing participants' motivation influenced their media multitasking behaviours over the course of the task. Presented first is a brief overview of Ralph and colleagues' (2021) methods and data preprocessing procedures, followed by a summary of their original analyses relevant to the current research question. Finally, changes in media multitasking over time are examined as a function of whether participants received the motivating or standard task instructions.

3.2.1 Materials and Methods

3.2.1.1 Participants

Ralph and colleagues (2021) collected a total of 166 participants, aged 17 to 35 years old (M_{age} = 19.43; SD_{age} = 2.47), from a SONA undergraduate participant pool at the University of Waterloo between the Fall 2017 and Winter 2018 semesters. Participants were tested in the laboratory in groups of 1 to 5 and received course credit in exchange for their participation. Prior to data preprocessing, the Control condition included 84 participants, while the Motivated condition included 82 participants.

3.2.1.2 Experimental Task and Motivation Manipulation

The 1-back paradigm was nearly identical to the paradigm described in Chapter 2, except that in this task, the stimuli were white and appeared on a black background. Importantly, before completing the 1-back task, participants in Ralph and colleagues' (2021) study were randomly assigned to either a Control or Motivated condition. In the Control condition, participants received

standard 1-back instructions, while in the Motivated condition, they received the following instructions informing them that they could leave the experimental session early if they performed sufficiently well on the task:

> "Before you begin, there is one more thing you should know.
>
> That is, as you know, this is a one-hour long study. However, depending on how well you do on the task, you may be able to leave about halfway through the task while still earning the full credit.
>
> To determine whether you get to leave early, during the task, the computer will monitor your performance on the task. After about 20 min, the task will temporarily stop, and the computer will compute your overall performance on the task up until that point, and then you will be notified if you have achieved a high enough level of performance to be let out of the study early while still receiving the full participation credit. If you do not achieve a high enough level of performance on the task, then you will have to complete the task for an additional 20 min, for a total time of nearly 1 h, as initially stated on SONA.
>
> One thing that is very important to note is that your decision to watch the video WILL NOT be considered when the computer analyzes your performance on the task.
>
> Do you have any questions?"

In reality, the study length was identical across conditions, such that participants in both groups only completed 20 minutes of the 1-back task.

3.2.1.3 Self-Reported Motivation Questions

A question previously employed by Seli and colleagues (2019) was used to probe motivation immediately after participants received the standard or motivating task instructions as well as after they completed the 1-back task. Participants were asked, "How motivated [are/were] you to do well on the primary task?" and responded on a Likert scale with response options ranging from 1 (not motivated at all) to 7 (very motivated).

3.2.1.4 Familiarity with the Video

Participants' familiarity with the video was assessed using the same question as in Chapter 2.

3.2.2 Results

3.2.2.1 Data Preprocessing

Data preprocessing procedures remained the same as those reported by Ralph and colleagues (2021). That is, prior to data analysis, participants with less than 30% hits or greater than 20% false alarms were removed from the dataset, as exceptionally poor performance on the 1-back raises concerns about whether participants understood the task instructions or were simply unwilling to comply with them. After removing nine participants who met these criteria, the sample consisted of 157 participants (44 male, 112 female, 1 non-binary) with an age range of 17 to 35 (M_{age} = 19.50, SD_{age} = 2.51). There were 78 participants in the Control condition and 79 in the Motivated condition.

3.2.2.2 Impact of Manipulation on Motivation

Changes in motivation from the start to the end of the task are illustrated in Figure 3.1. Results of a mixed factorial ANOVA with condition (Motivated versus Control) as a between-participants factor and time (pre- versus post-task) as a within-participants factor indicated that there was a main effect of condition, $F(1, 155) = 15.86$, $p < .001$, $\eta_p^2 = .09$, with participants in the Motivated condition reporting higher levels of motivation than participants in the Control condition. There was also a main effect of time, $F(1, 155) = 9.21$, $p = .003$, $\eta_p^2 = .06$, such that participants were more motivated at the start of the task compared to the end of the task. There was no significant interaction between condition and time, $F(1, 155) = 1.35$, $p = .247$, $\eta_p^2 = .01$.

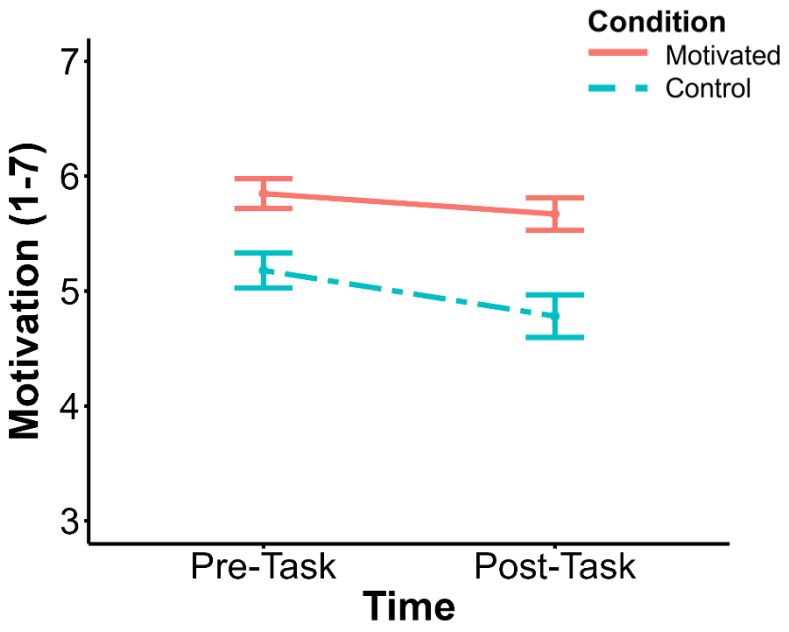


Figure 3.1. Graph depicting mean (±SE) levels of motivation before and after participants completed the 1-back task.

3.2.2.3 Impact of Motivation on Media Multitasking

To examine changes in media multitasking over the course of the 1-back in this reanalysis, the task was divided into nine blocks of 52 trials, and the sum of the trials participants spent with the video on was calculated for each block. A Generalized Linear Mixed Model (GLMM) was then employed to determine whether patterns of media multitasking throughout the 1-back varied across blocks and motivation conditions. The GLMM was specifically chosen for two reasons. First, the media multitasking data were highly positively skewed (Figure 3.2). While the majority of participants played the video at some point during the study, 36% of participants in the Control condition never played the video whereas a higher percentage (46%) of participants in the Motivated condition chose not to play the video. Second, it was anticipated that participants' likelihood of playing the video in a given block would be heavily influenced by whether they had done so in previous blocks. That

is, levels of media multitasking were likely to be correlated across blocks. The GLMM addressed these issues by specifying a non-normal distribution for the outcome variable (total trials spent media multitasking) and allowing changes in media multitasking over the nine blocks to vary across participants. In the present model, condition (with the Control condition as the reference group) and block (standardized to improve model convergence) were included as fixed effects. The intercept and slope for block were allowed to vary across participants, and a Poisson distribution was specified for the skewed outcome variable.

As shown in Table 3.1, results of the GLMM revealed that, while there was no effect of condition or block on media multitasking, there was a significant interaction between these factors, indicating that participants in the Motivated condition showed more gradual increases in media multitasking over time compared to participants in the Control condition (Figure 3.2).

Table 3.1.

GLMM Predicting Changes in Media Multitasking Based on Block and Condition

Fixed Effects	Estimate	SE	*Z*	*p*
Intercept	-0.45	0.62	-0.72	.469
Condition (Motivated Group)	-1.39	0.85	-1.63	.104
Block	-0.24	0.20	-1.20	.231
Block*Condition	-0.46	0.21	-2.17	.030

Note. $N = 157$. Coefficients for the effect of condition are shown for the Motivated condition (Control is the reference group). *P*-values are based on Wald χ-tests comparing estimates against zero.

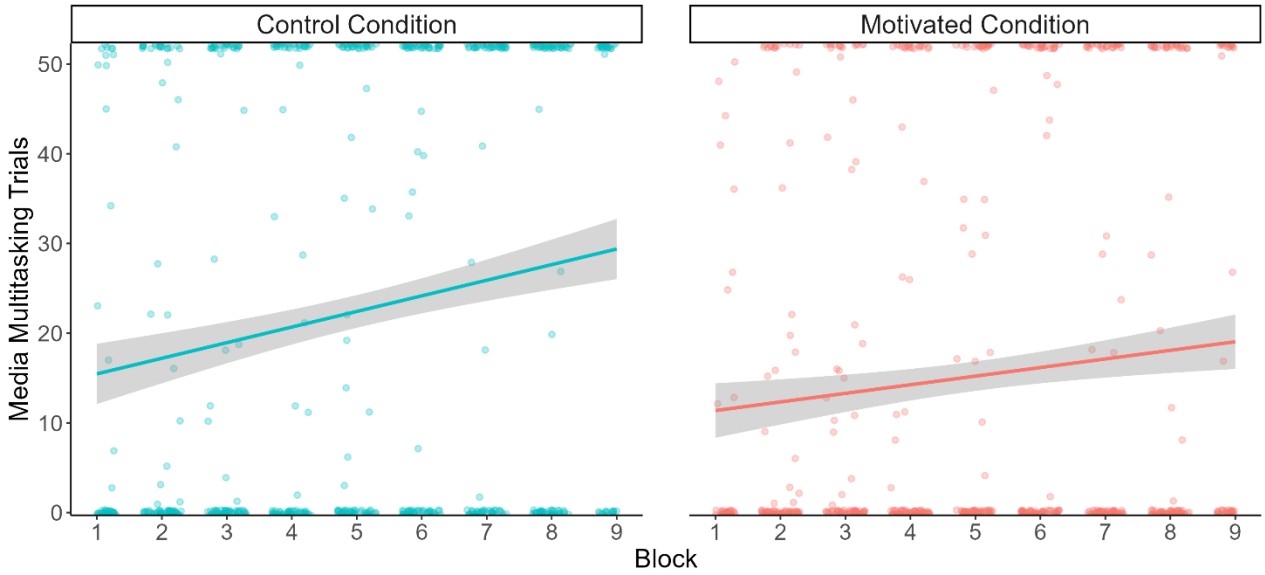


Figure 3.2. Scatterplots depicting changes in media multitasking over successive blocks of the 1-back for participants in the Control condition (left) and Motivated condition (right). Data points are jittered to increase their visibility. Regression lines are fitted to the data and shading represents 95% confidence intervals.

3.2.2.4 Changes in Task Performance Over Time

To assess how performance changed over the course of the 1-back, proportion of hits and false alarms were computed for each of the nine blocks of 52 trials in the 1-back task. These data are shown in Figure 3.3. Two mixed factorial ANOVAs were then conducted with condition as a between-participants factor, block as a within-participants factor, and either proportion of hits or proportion of false alarms as the dependent variable. Mauchly's tests indicated that the assumption of sphericity was violated for both proportion of hits ($W = 0.27$, $p < .001$) and proportion of false alarms ($W = 0.00$, $p < .001$); therefore, results are presented after applying a Greenhouse-Geisser correction ($\varepsilon_{\textit{proportion hits}} = 0.69$, $\varepsilon_{\textit{proportion false alarms}} = 0.28$).

For the proportion of hits, there was a main effect of condition, $F(1, 155) = 10.81$, $p < .001$, $\eta_p^2 = 0.07$, with participants in the Control condition displaying a lower proportion of hits than participants in the Motivated condition. There was also a main effect of block, $F(5.55, 860.04) =$

12.23, $p < .001$, $\eta_p^2 = .07$, indicating that the proportion of hits declined over time-on-task. Additionally, there was a significant interaction between condition and block, $F(5.55, 860.04) = 3.24$, $p = .005$, $\eta_p^2 = .02$, such that participants in the Motivated condition displayed more gradual declines in performance over time than participants in the Control condition.

For the proportion of false alarms, there was no main effect of condition, $F(1, 155) = 0.39$, $p = .535$, $\eta_p^2 < .01$, or Block, $F(2.26, 349.84) = 2.18$, $p = .108$, $\eta_p^2 = .01$, nor was there a significant interaction between condition and block, $F(2.26, 349.84) = 0.21$, $p = .834$, $\eta_p^2 < .01$.

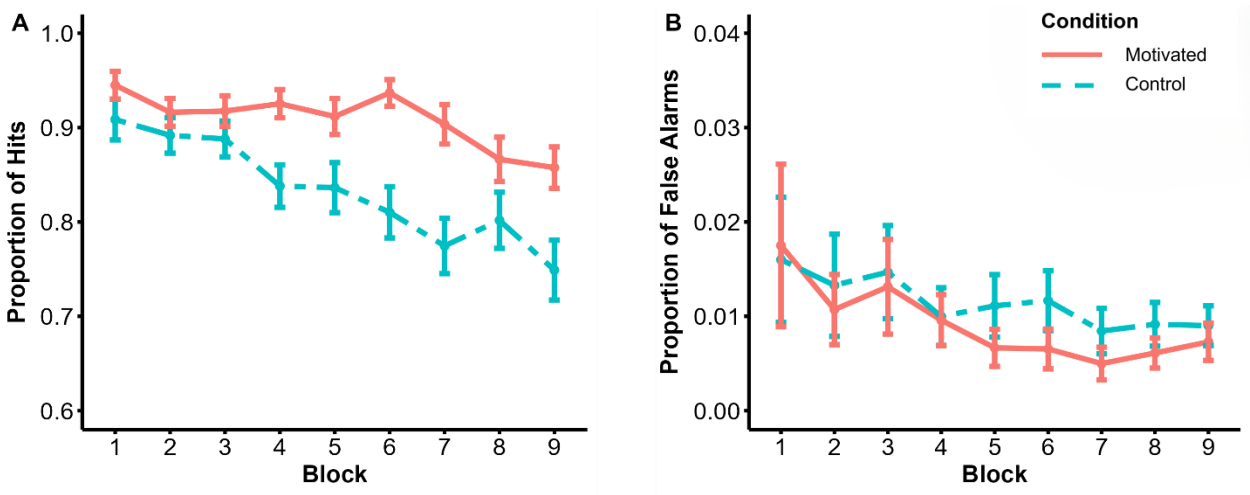


Figure 3.3. Line graphs depicting mean (±SE) proportion of hits (A) and false alarms (B) over successive blocks of the 1-back task as a function of condition.

3.2.3 Discussion

As hypothesized, temporal increases in media multitasking were attenuated for participants in the Motivated condition compared to those in the Control condition. Moreover, consistent with the notion that media multitasking negatively impacts task performance, decreases in performance over time were more gradual in the Motivated condition relative to the Control condition. These

findings suggest that increasing participants' motivation to complete a task can help them delay engaging in other activities like media multitasking for longer than they otherwise would.

3.2 Study 3.2

Study 3.2 aimed to replicate and extend the findings from Study 3.1 by critically assessing in-the-moment changes in motivation throughout the 1-back task to understand how manipulating motivation impacts not only media multitasking and performance, but also self-reported levels of motivation over time-on-task. In addition to including in-the-moment assessments of motivation, for exploratory purposes, this study included questions assessing participants' experiences of the 1-back task. Specifically, participants' interest in and enjoyment of the 1-back were examined because these experiences may play a role in individuals' intrinsic motivation to complete a task. To gain a deeper understanding of the effect of the motivation manipulation, this study also asked participants in the Motivated group how motivated they were to complete the task, given the motivating instructions.

3.3.1 Materials and Methods

3.3.1.1 Participants

A total of 428 participants (1 agender, 6 genderqueer, 76 men, 339 women, 6 no answer provided) were recruited from the SONA online participant pool at the University of Waterloo. Two hundred and eighteen participants were assigned to the Motivated condition, and 210 participants were assigned to the Control condition. Participants were provided a link to the study website and completed the study online in exchange for course credit. Based on responses from the 414 participants who provided information regarding their age, the sample ranged between 17 and 44 years of age (M_{age} = 20.04; SD_{age} = 3.36).

3.3.1.2 Experimental Task and Motivation Manipulation

The 1-back media multitasking paradigm and motivation manipulation were identical to those employed by Ralph and colleagues (2021).

3.3.1.3 Self-Reported Motivation Questions

Motivation was assessed before and after the 1-back task as well as on nine occasions throughout the 1-back using similar questions to those employed by Ralph and colleagues (2021). Specifically, participants were asked "How motivated [are/were] you to do well on the (1-back) task?". Responses were provided using a 1 (not at all motivated) to 7 (very motivated) Likert scale. Motivation probes administered during the 1-back were pseudo-randomly positioned and set to occur once within each block of 52 trials.

3.3.1.4 Motivation-related Experiences

Three post-task questions queried several experiences that were deemed to be relevant to participants' feelings of motivation during the study. To assess their enjoyment of the 1-back task, participants were asked, "How much did you enjoy completing the 1-back task?". Response options for this question ranged from 1 (I did not enjoy it at all) to 7 (I enjoyed it very much). Participants' level of interest in the task was assessed using the question, "How interesting was it to complete the 1-back task?", with response options ranging from 1 (not at all interesting) to 7 (very interesting). Finally, to further understand the impact of the motivation manipulation, participants in the Motivated condition were asked, "How motivated were you to do well on the 1-back task, given that you were allowed to leave early?". Response options ranged from 1 (not at all motivated) to 7 (very motivated).

3.3.1.5 Post-Task Multitasking Questions

As this study was conducted online without researcher supervision, it was possible for participants to engage in activities outside the experimental context (i.e., beyond the 1-back task or optional video). Therefore, a post-task question similar to the one employed in Chapter 2 was used to assess the extent of such behaviour. Specifically, participants were asked, "Were you engaged in any tasks other than those related to the experiment?" and could select either "Yes" or "No." They were then asked, "If so, did any of these activities involve the use of multimedia devices (e.g., smartphones, laptops, tablets, etc.)?", with response options of "Yes," "No," or "Not applicable - I was completely on task the entire time."

For the purposes of the present analyses and for consistency across Studies 3.1 and 3.2, participants who indicated that they engaged in activities outside the experimental context were not removed. However, because it is possible that the pattern of effects could be impacted by individuals who engaged in alternate, and possibly more personally relevant, forms of media multitasking outside of the study context, for the sake of completion, included within Appendix A are the following analyses, conducted: (1) when excluding participants who engaged in tasks outside of the experimental context (i.e., who responded "Yes" to the first question), and (2) when including *only* participants who engaged in tasks outside of the experiment. Summaries of these findings are also described in brief below[3].

[3] It should be noted that the method used to compare results for participants who did and did not media multitask with activities outside the experimental context differs from the method used in Chapter 2. Whereas Chapter 2 examined differences between participants who reported engaging with media-related activities during the study and those who did not engage in multitasking of any kind (i.e., with the optional video or activities outside the experimental context), the present study compares participants who reported engaging in any outside activities (media-related or -unrelated) to those who reported only attending to the experimental content. These differences across chapters were maintained to ensure consistency with the results reported in the published article; however, results of Study 3.2 after applying the methods used in Chapter 2 can be found in Appendix B.

3.3.1.6 Familiarity with the Video

As in Ralph and colleagues' (2021) study, participants' familiarity with the optional video was assessed using the question, "Have you seen the video used in this experiment before?". Participants could respond with "Yes", "No" or "Not applicable – I didn't watch the video". Since only two participants in each condition reported having previously seen the video, responses to this question were not used for data filtering purposes and are not included in subsequent analyses.

3.3.2 Results

3.3.2.1 Data Preprocessing

To remain consistent with the data preprocessing methods employed in Ralph and colleagues' (2021) study as well as the previous chapter, participants with less than 30% hits and greater than 20% false alarms were removed prior to analysis of the data. Following data removal, the sample consisted of 284 participants (1 agender, 5 genderqueer, 45 men, 231 women, 2 no answer). There were 154 participants in the Motivated condition and 130 participants in the Control condition. Based on the 279 responses to the age question, the final sample ranged from 17 to 44 years old (M_{age} = 20.00, SD_{age} = 3.40).

3.3.2.2 Impact of Manipulation on Motivation

Although both conditions started the task with similar levels of motivation, ratings of motivation during and following completion of the task differed across conditions (Figure 3.4). As in Study 3.1, pre- and post-task ratings of motivation were compared across conditions using a mixed factorial ANOVA with condition (Motivated or Control) as a between-participants factor and time (pre- or post-task) as a within-participants factor. No difference was found across conditions, $F(1, 282) = 3.26$, $p = .072$, $\eta_p^2 = 0.01$. There was, however, a main effect of time, $F(1, 282) = 237.88$, $p < .001$, $\eta_p^2 = 0.46$, with motivation levels decreasing from the start to the end of the task (Figure

3.4A). The interaction between condition and time did not reach significance, $F(1, 282) = 3.78$, $p = .053$, $\eta_p^2 = 0.01$.

Next, changes in motivation over the course of the 1-back task were examined using a mixed factorial ANOVA with condition as a between-participants factor and block (corresponding to the nine probes in the 1-back) as a within-participants factor. Two participants with missing responses on one or more of the probes were removed from this analysis. Mauchly's test indicated that the assumption of sphericity was violated ($W = 0.04$, $p < .001$); therefore, a Greenhouse-Geisser correction was applied ($\varepsilon = 0.46$). There was a significant main effect of condition, $F(1, 270) = 10.60$, $p = .001$, $\eta_p^2 = 0.04$, indicating that participants in the Motivated condition were overall more motivated than those in the Control condition. There was also a main effect of block, $F(3.71, 1001.49) = 138.13$, $p < .001$, $\eta_p^2 = 0.34$, with motivation decreasing over the course of the task. Additionally, there was an interaction between condition and block, $F(3.71, 1001.49) = 3.64$, $p = .007$, $\eta_p^2 = 0.01$, such that participants in the Motivated condition began the task with similar levels of motivation as those in the Control condition, but showed slower declines in motivation over time (Figure 3.4B).

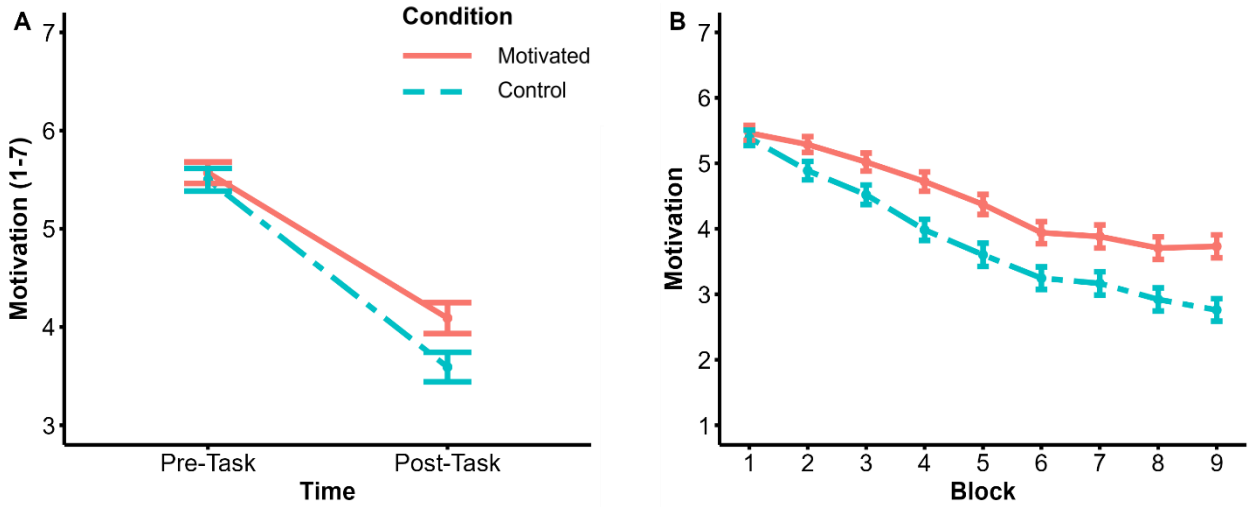


Figure 3.4. Graphs depicting mean (±SE) levels of motivation before and after the 1-back (A) as well as over successive blocks of the 1-back (B) as a function of condition.

3.3.2.3 Impact of Motivation Manipulation on Media Multitasking

As in Study 3.1, to examine changes in media multitasking over the course of the 1-back task, the task was divided into nine blocks of 52 trials. The total number of trials during which participants engaged in media multitasking was calculated for each block. Changes in media multitasking as a function of time and condition were assessed using a GLMM, with condition (Control as the reference group) and block (standardized) as fixed effects, and intercepts and slopes that were allowed to vary randomly by participant and block. A Poisson distribution was specified for the outcome variable (media multitasking). Results of the GLMM are shown in Table 3.2. While there was no main effect of block, there was a main effect of condition. Importantly, this effect was qualified by an interaction between condition and block, indicating that increases in media multitasking over time were more gradual for those in the Motivated condition compared to those in the Control condition (Figure 3.5).

Table 3.2.

GLMM Results With Block, Condition and Their Interaction Predicting Media Multitasking

Fixed Effects	Estimate	SE	z	p
Intercept	-0.20	0.41	-0.49	.626
Condition (Motivated Group)	-2.34	0.57	-4.11	< .001
Block	0.03	0.13	0.21	.832
Block*Condition	-0.34	0.16	-2.09	.037

Note. Coefficients for the effect of condition are shown for the Motivated condition (Control is the reference group). *P*-values are based on Wald z-tests comparing estimates against zero. $N = 284$.

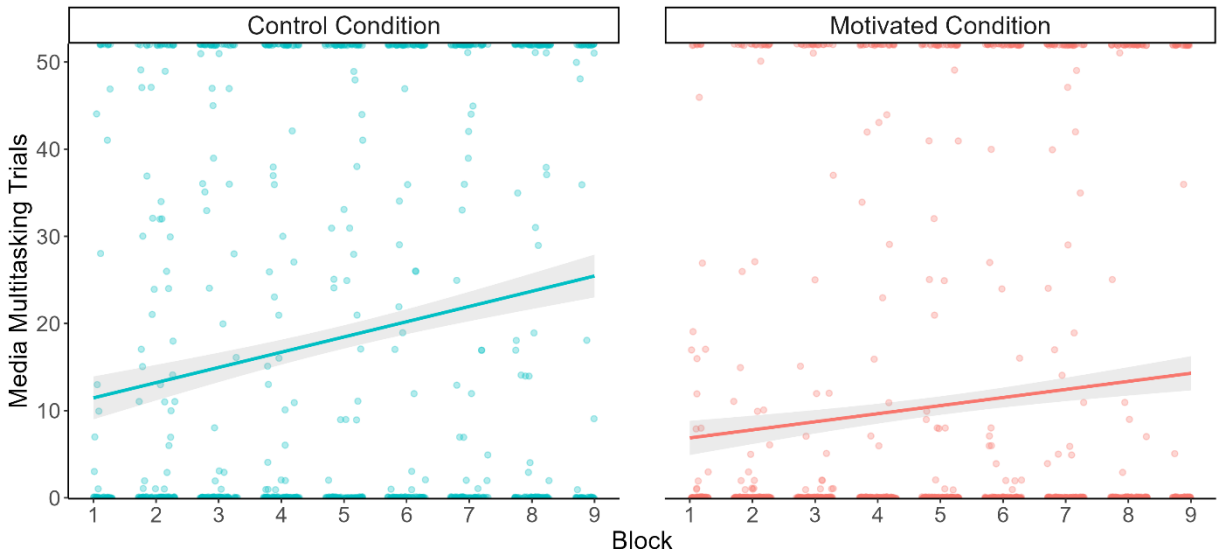


Figure 3.5. Scatterplots illustrating changes in media multitasking over successive blocks of the 1-back for those in the Control condition (left) and Motivated condition (right). Data points are jittered to increase their visibility. Regression lines are fitted to the data and shading represents 95% confidence intervals.

3.3.2.4 Changes in Task Performance Over Time

As in Study 3.1, the proportion of hits and false alarms were calculated for each of the nine blocks of the 1-back (Figure 3.6), and changes in performance over time were evaluated using mixed factorial ANOVAs with either proportion of hits or proportion of false alarms as the dependent variable, condition as a between-participants factor and block as a within-participants factor. Mauchly's tests indicated that the assumption of sphericity was violated for the ANOVAs for both the proportion of hits ($W = 0.55$, $p < .001$) and the proportion of false alarms ($W = 0.67$, $p < .001$). Results are therefore presented using Greenhouse-Geisser estimates of sphericity ($\varepsilon_{\textit{proportion hits}} = 0.56$, $\varepsilon_{\textit{proportion false alarms}} = 0.91$).

Concerning the proportion of hits, there was a main effect of condition, $F(1, 282) = 10.72$, $p = .001$, $\eta_p^2 = .04$, indicating that hit rates were higher in the Motivated condition compared to the Control condition. Additionally, there was a main effect of block, $F(4.43, 1249.87) = 60.05$, $p < .001$,

$\eta_p^2 = .18$, such that the proportion of hits declined over time. A significant interaction between condition and block was also observed, $F(4.43, 1249.87) = 5.77$, $p < .001$, $\eta_p^2 = .02$, revealing that proportion of hits decreased more gradually over time in the Motivated condition compared to the Control condition.

As in Study 3.1, the proportion of false alarms were at floor and showed no main effect of condition, $F(1, 282) = 0.71$, $p = .399$, $\eta_p^2 < .01$, or block, $F(7.26, 2048.41) = 0.83$, $p = .565$, $\eta_p^2 < .01$, was found. There was no interaction between condition and block, $F(7.26, 2048.41) = 0.61$, $p = .753$, $\eta_p^2 < .01$.

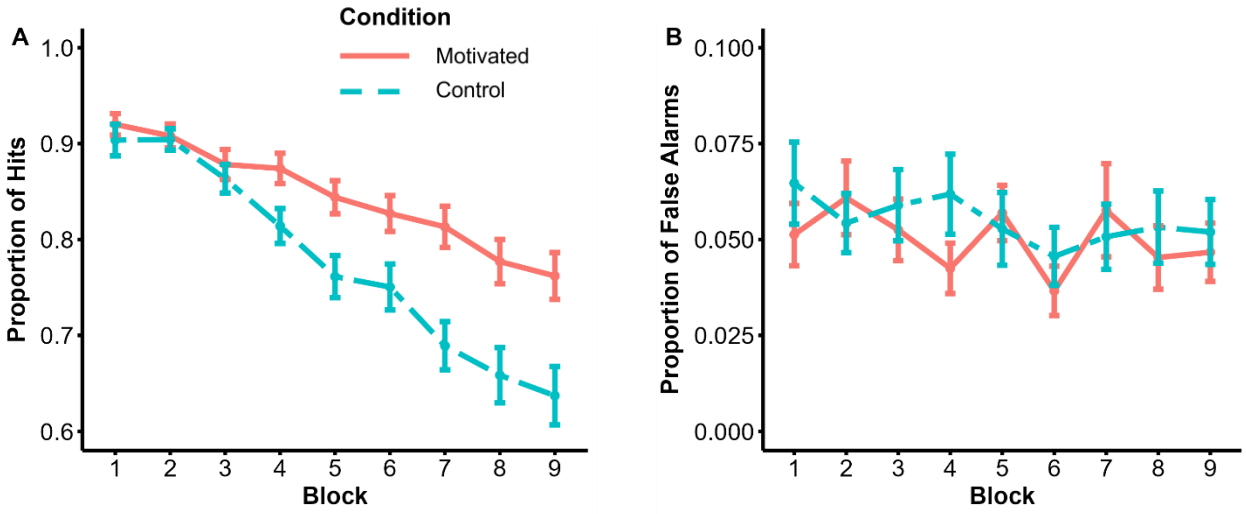


Figure 3.6. Line graphs depicting mean (±SE) proportion of hits (A) and proportion of false alarms (B) over successive blocks of the 1-back for participants in the Motivated and Control conditions.

3.3.2.5 Motivation-related Experiences

Participants in the Motivated ($M = 2.68$, $SD = 1.48$) and Control ($M = 2.64$, $SD = 1.53$) conditions did not differ in terms of their enjoyment of the 1-back, $t(282) = 0.24$, $p = .809$, $d = .03$ or how interesting they found the task, $t(282) = 0.34$, $p = .731$, $d = .04$ ($M_{Motivated} = 2.38$, $SD_{Motivated} = 1.52$; $M_{Control} = 2.45$, $SD_{Control} = 1.57$). Overall, participants in the Motivated condition reported that

they were motivated by the instructions informing them that they could leave the task early, scoring near the midpoint (M = 5.29, SD = 1.79) on the 7-point Likert scale, where 1 represented "not at all motivated" and 7 represented "very motivated".

3.3.2.6 Post-Task Multitasking Questions

Of the 282 participants who provided complete responses to the question assessing whether they had engaged in tasks other than those provided within the experimental context, 57 participants in the Control condition (approximately 45%) and 56 participants in the Motivated condition (36%) responded "Yes". Responses to this question did not differ across conditions, $X^2(1) = 1.62$, $p = .204$. Based on the 282 participants who provided complete responses as to whether these activities involved the use of multimedia devices, 44 participants in the Control condition (34%) and 48 participants in the Motivated condition (31%) responded "Yes". Once again, responses did not differ across conditions, $X^2(2) = 4.94$, $p = .085$.

When re-analyzing the data after excluding participants who engaged in activities outside the experimental context (N = 169, 71 Control, 98 Motivated), and when re-analysing the data for participants who reported engaging in other activities during the experiment (N = 113, 57 Control, 56 Motivated; Appendix A), results were similar. Patterns for these subgroups resembled the patterns observed in the full sample, although certain effects did not reach significance. Differences between conditions were particularly small in the subsample who reported engaging in tasks other than those related to the experiment. The results of these analyses are described in greater detail within Appendix A.

3.3.3 Discussion

Despite participants in both conditions frequently reporting engaging in activities outside the experimental context, results largely resembled those of Study 3.1. That is, participants in the

Motivated condition showed more gradual increases in media multitasking as well as slower reductions in performance over time compared to those in the Control condition. While both conditions began the study with similar levels of motivation, those in the Motivated condition showed slower declines in motivation over time. Moreover, participants in the Motivated condition reported being specifically motivated by the possibility of leaving the experiment early, although their interest in and enjoyment of the 1-back did not differ from participants in the Control condition. These results largely align with the view that temporal changes in motivation are related to changes in media multitasking over time. Furthermore, they suggest that minimizing decreases in motivation over time may be an effective strategy for mitigating temporal increases in media multitasking and accompanying performance declines.

3.4 General Discussion

The re-analysis and original study in the current chapter examined the impact of motivation on media multitasking over time-on-task. Media multitasking was found to increase with time-on-task while performance decreased; however, these trends were attenuated in participants who received motivating versus standard task instructions. Additionally, decreases in self-reported motivation were found to accompany increases in media multitasking and decreases in performance over time. These decreases in motivation occurred more gradually for those who received the motivating instructions compared to those who received the standard instructions. In all, findings from the present studies suggest that temporal changes in media multitasking may be linked to changes in motivational factors, and that increasing motivation can improve individuals' ability to sustain their attention, presumably by increasing the value they assign to attending to current versus alternative activities. These findings also align with accounts that attribute sustained attention

decrements to varying cost-benefit analyses rather than a gradual depletion of resources over time (e.g., Kurzban et al., 2013).

Chapter 4: Interactions between individual differences and contextual factors

4.1 Introduction

The current media multitasking research has predominantly examined the individual difference factors that predict general media multitasking tendencies and the more direct situational influences on this behaviour separately. To gain a more holistic understanding of the drivers of media multitasking, the present study joined these two areas of research by addressing two key questions. First, given that individual difference factors have been shown to predict general media multitasking tendencies (e.g., Fisher et al., 2023; Moisala et al., 2016; Shin & Murphy, 2025; Toyama & Hayashi, 2022, 2023; Xu et al., 2016), albeit somewhat inconsistently across studies (Parry & Le Roux, 2021; Wiradhany & Koerts, 2021; Wiradhany & Nieuwenstein, 2017), do they predict in-the-moment instances of media multitasking?

Prior work has found associations between traits related to poor sustained attention (Fisher et al., 2023; Moisala et al., 2016; Ralph et al., 2014; Rioja et al., 2023; Sansevere & Ward, 2021; Shin et al., 2024; Yildirim & Dark, 2018) and higher scores on questionnaires assessing the extent of individuals' media multitasking in daily life. It therefore seems likely that individuals high in these traits would also be more likely to media multitask during experimental tasks requiring sustained attention. To investigate this possibility, individual differences in attention-related cognitive errors, attention lapses and mind-wandering were examined in relation to media multitasking during the 1-back task. Importantly, a distinction was made between spontaneous and deliberate mind-wandering, which refer to unintentional and intentional instances of this experience, respectively (Seli et al., 2015, 2016; Vannucci & Chiorri, 2018), as these two forms of mind-wandering may predict media multitasking differently. Although one might expect frequent spontaneous mind-wandering to predict greater media multitasking, especially if the

behaviour has become habitual and is often engaged in mindlessly, deliberate mind-wandering may be a stronger predictor, as media multitasking is typically a voluntarily selected behaviour.

Other traits broadly related to self-regulation have also been associated with media multitasking. For example, higher levels of conscientiousness, characterized by a tendency to be goal-directed and capable of delaying gratification (Roberts et al., 2009), have been associated with a decreased likelihood of media multitasking (Ma et al., 2024; Toyama & Hayashi, 2022, 2023). Along similar lines, higher self-control has been associated with lower levels of media multitasking (Luo et al., 2024; Shin et al., 2019; Xu et al., 2016). Finally, those high in boredom proneness may be more likely to engage in media multitasking. Individuals high in boredom proneness often report low levels of self-control (Isacescu et al., 2017; Isacescu & Danckert, 2018; Wolff et al., 2022) as well as higher levels of sensation-seeking (Dahlen et al., 2005; Kass & Vodanovich, 1990) and impulsivity (Dahlen et al., 2004, 2005; Watt & Vodanovich, 1992), which may increase their likelihood of engaging with media as a means of alleviating boredom. In line with this notion, some studies have noted positive relations between boredom proneness and media multitasking (Drody et al., 2022; Mayl et al., 2023), although this relation did not emerge in Chapter 2. Notably, boredom proneness is also characterized by a failure to launch into meaningful action (Danckert, 2019; Mugon et al., 2018), which could sometimes lead to null or negative associations between this trait and media multitasking. Given their previously demonstrated relations with media multitasking, the present study examined conscientiousness, self-control, and boredom proneness as additional predictors of media multitasking.

The second question addressed here concerned whether the relations between individual difference factors and media multitasking in the laboratory would vary based on key contextual

variables with more immediate effects on media multitasking. To address this question, relations between the aforementioned traits and media multitasking were examined during both high and low-demand tasks. Task demand was chosen as the contextual variable of interest since prior work has shown that individuals media multitask more during low- versus high-demand tasks (Ralph et al., 2020). It was hypothesized that greater tendencies towards inattention and traits associated with poor self-regulation would be associated with greater media multitasking overall; however, these relations were expected to vary based on task demand. Weaker associations were expected during the low-demand task, as this version should be easy to complete even while playing the task-irrelevant video, leading to high rates of media multitasking regardless of individual differences. Conversely, stronger relations were expected in the high-demand task, where multitasking is more likely to impair performance. In this context, individuals with greater tendencies towards inattention and those high in traits indicative of poor self-regulation may remain likely to media multitask despite the greater risk associated with the behaviour.

In addition to the foregoing main questions, this study also took the opportunity to explore whether individuals' self-reported media multitasking tendencies would predict in-lab media multitasking. These tendencies were assessed using the Media Multitasking Index (Ophir et al., 2009) as well as a more recent and concise variant, the Short Media Multitasking Measure (Baumgartner et al., 2017). This measure focuses on a more commonly used subset of the media included in the Media Multitasking Index and has been shown to share many of the same correlates (Baumgartner et al., 2017). While an intuitive assumption is that self-reported media multitasking tendencies should predict media multitasking during sustained attention tasks, the small number of studies that have examined the relation between Media Multitasking Index

scores and in-the-moment instances of media multitasking have generally failed to yield significant associations (Lopez & Orr, 2022; Lui et al., 2023; Shih, 2013; although, see Rigby et al., 2017). Consequently, an exploratory approach was taken when investigating this issue. Finally, to better understand participants' experiences during the high- and low-demand tasks, which could provide context for their media multitasking behaviours, levels of state boredom and effort devoted to the tasks were assessed throughout the study. In line with findings from Ralph and colleagues (2020), levels of boredom were expected to be higher, and ratings of effort were expected to be lower during the low- versus high-demand task.

4.2 Methods

4.2.1 Participants

A total of 521 undergraduate students from the University of Waterloo consented to take part in the study and accessed experiment via a link provided on the online recruitment site (SONA). Sixty participants were removed for having unusable data files (e.g., due to refreshing the page multiple times, resulting in files with multiple partial attempts at completing the study) or for failing to complete the experimental task. Applying the same performance filters used in the previous chapters (i.e., removing those with less than 30% hits or greater than 20% false alarms) further reduced the sample to 166 participants. A final two participants were removed for having implausible responses on the questionnaires (i.e., reporting engaging with multiple forms of media 24 hours per day and reporting that they were 100 years old). Thus, the final sample used in the analyses consisted of 164 participants (37 men, 110 women, 7 gender queer/gender non-conforming/gender non-binary, 10 declined to respond) with ages ranging from 18 to 46 years old (M_{age} = 21.01, SD = 4.33).

4.2.2 N-back Tasks and Media Multitasking

Participants completed two versions of the *n*-back task (Kirchner, 1958): a 0-back and a 2-back task, with the order of tasks being counterbalanced. Eighty-six participants completed the 0-back first while 78 completed the 2-back first. Each of the tasks included 9 practice trials which were omitted from the analyses, as well as 234 experimental trials. On each trial, participants viewed a letter (B, F, K, H, M, Q, R, X, or Z) on the screen for 500 milliseconds followed by a fixation cross for 2000 milliseconds. The colour scheme depended on whether participants completed the study with their browser in "Dark Mode". If participants used the standard browser settings, letters and fixation crosses appeared in black font against a white background; if participants completed the study in dark mode, the letters appeared in white font against a dark grey background. The 0-back required participants to respond when the letter 'X' appeared on the screen, while the 2-back required participants to respond when the letter currently on the screen matched the letter presented two trials back. Responses to these target stimuli were provided by pressing the space key. Performance on the *n*-back tasks was evaluated based on proportion of hits (i.e., the proportion of trials on which participants correctly responded to target stimuli) and proportion of false alarms (i.e., the proportion of trials on which participants incorrectly responded to non-target stimuli).

As in the previous chapters, prior to commencing the first *n*-back task, participants were informed that they had the option to play a task-irrelevant video (Brain Magic) while completing the experimental task. The task began with the video off, but participants could turn the video on or off again at any time by pressing the 't' key. The video state remained unchanged when participants transitioned from their first task to the second. For example, if a participant played

the video during the 0-back and did not turn it off before the task ended, the 2-back would begin with the video still playing. On the other hand, if the video was off prior to the 0-back ending, the 2-back would commence with the video off. Levels of media multitasking were measured for each task in terms of the total number of trials participants spent with the video on.

4.2.3 Probes

During each version of the *n*-back, participants responded to four boredom and four effort probes. A practice probe was also embedded within the practice trials preceding each task; however, these responses were not included in the present analyses. The boredom probes asked participants "How bored do you feel right now?" and allowed participants to select a response using a slider with anchors ranging from 1 (not bored at all) to 100 (very bored). The effort probes asked participants, "How much effort were you exerting to perform well on this task?". Responses were provided on a slider scale with options ranging from 1 (no effort at all) to 100 (a lot of effort). Probes were coded to appear randomly within each block of 58 trials, with the constraint that two probes could not appear within five trials of one another. Probe responses were averaged within each level of task difficulty to give an indicator of participants' levels of boredom and expended effort during the 0-back and 2-back tasks.

4.2.4 Individual Difference Factors

The measures assessing attention-related and self-regulatory traits were administered as part of the Mass Testing Survey at the University of Waterloo. This survey consists of a variety of measures selected by researchers within the Department of Psychology and is completed each

semester by students enrolled in psychology courses. The measures relevant to the current research questions are discussed in greater detail below. Questionnaire measures of media multitasking (also discussed below) were administered immediately after participants completed the experimental tasks.

4.2.4.1 Attention-Related Measures

4.2.4.1.1 Attention-Related Cognitive Errors. The Attention-Related Cognitive Errors Scale (ARCES; Cheyne et al., 2006) is a measure of participants' tendency to make mistakes due to inattentiveness. Participants respond to 12 items, such as "When reading I find that I have read several paragraphs without being able to recall what I read." using a Likert scale ranging from 1 (never) to 5 (very often). Cheyne and colleagues (2006) report internal consistencies of .88 and .89.

4.2.4.1.2 Mindful Attention Awareness Scale-Lapses Only. The Mindful Attention Awareness Scale-Lapses Only (MAAS-LO; Carriere et al., 2008) requires participants to report how often they experience lapses of attention in everyday life (e.g., "I find it difficult to stay focused on what's happening in the present."). Responses are provided on a Likert scale ranging from 1 (almost never) to 6 (almost always). Carriere and colleagues (2008) report an internal consistency of .83.

4.2.4.1.3 Spontaneous and Deliberate Mind-Wandering Scales. The Spontaneous and Deliberate Mind-Wandering Scales (Carriere et al., 2013) assess the extent to which individuals experience unintentional or intentional mind-wandering, respectively, in daily life. Spontaneous mind-wandering questions include "It feels like I don't have control over when my

mind wanders," while deliberate mind-wandering items include "I allow my thoughts to wander on purpose". Participants respond using a Likert scale ranging from 1 to 7, with anchors of either "rarely" and "a lot", or "almost never" and "almost always", depending on the phrasing of the item. These scales have demonstrated strong internal consistencies ($\alpha_{spontaneous}$ = .88 and .90, $\alpha_{deliberate}$ = .88 and .84).

4.2.4.2 Measures Related to Self-Regulation

4.2.4.2.1 Conscientiousness. The Conscientiousness subscale of the Short Big Five Index (Lang et al., 2011) was used to assess conscientiousness. This three-item subscale asks participants to rate the extent to which they see themselves as someone who "does a thorough job", "tends to be lazy" (reverse-scored) and "does things efficiently". Responses are provided on a Likert scale with response options ranging from 1 (strongly disagree) to 7 (strongly agree). While this subscale has previously shown low internal consistency (α = .60) due to its limited number of items, Lang and colleagues (2011) report that this measure maintains good construct validity.

4.2.4.2.2 Brief Self-Control Scale. The Brief Self-Control Scale (BSCS; Tangney et al., 2004) includes 13 items assessing trait levels of self-control (e.g., "I am good at resisting temptation"). Participants respond on a Likert scale ranging from 1 (not at all) to 5 (very much). This scale has demonstrated good internal consistencies (α = 0.83 and 0.85).

4.2.4.2.3 Short Boredom Proneness Scale. The Short Boredom Proneness Scale (Struk et al., 2017) assesses an individual's proneness towards boredom. Participants use a Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) to rate their agreement with statements

such as “In most situations, it is hard for me to find something to do or see to keep me interested”. This scale has demonstrated excellent internal consistency (α = .88; Struk et al., 2017).

4.2.5 Media Multitasking Questionnaires

4.2.5.1 Media Multitasking Index

The Media Multitasking Index (Ophir et al., 2009) evaluates the extent to which individuals combine 12 different forms of media: print-based media, television, computer videos, music, non-music audio, computerized games, phone calls, instant messaging, text messaging, email, web surfing and other computer-based applications. The measure typically first asks participants to indicate how many hours they spend using each form of media weekly. Participants are then asked to report how frequently they pair each of the media types using response options of “Most of the time”, “Some of the time”, “A little of the time” or “Never”. These responses are recoded as 1, 0.67, 0.33, and 0, respectively. Scores on the Media Multitasking Index are calculated by multiplying each multitasking frequency rating by the time spent using the corresponding primary medium, summing these values, and dividing this sum by the total time spent using all media types (Ophir et al., 2009). To remain consistent with Ophir and colleagues' (2009) methods, hours spent text messaging was omitted from the calculation, although responses about the extent to which participants texted while using other media were still included.

Notably, in the present study, an error occurred in which participants were asked to report how many hours *per day* (0–24) they engaged with each medium, rather than *per week* as specified in the original Media Multitasking Index (Ophir et al., 2009). While this represents a

deviation from the original measure, other researchers have relied on daily rather than weekly estimates of media use when employing very similar measures of media multitasking (e.g., Matthews et al., 2022; Pea et al., 2012) as well as the Media Multitasking Index (Shukla et al., 2021). It should also be noted that, despite this deviation, like the original Media Multitasking Index, the measure employed in the present study still provides a weighted average of participants' overall tendency to media multitask.

4.2.5.2 The Short Media Multitasking Measure

The Short Media Multitasking Measure (Baumgartner et al., 2017) was originally created as a shorter alternative to the Media Multitasking Index for use in adolescent samples; however, it has since been used in large-scale study of adults (Wiradhany et al., 2020). This measure asks participants to rate, on a scale ranging from 1 (never) to 4 (very often), how often participants combine four types of media: watching television, listening to music, sending messages (via phone or computer) or using social networking sites. Responses on items of the Short Media Multitasking Measure are averaged. Baumgartner and colleagues (2017) reported excellent internal consistencies, with Cronbach's alphas ranging from 0.88 to 0.90.

4.2.6 Post-Task Extra-Experimental Media Multitasking Question

Extra-experimental media multitasking was assessed using the same question and response options (i.e., "Yes", "No, I didn't engage in any activities outside the contents of this study" and "No, but I was engaged in other, media-unrelated activities while completing the study) described in Chapter 2.

4.3 Results

4.3.1 Media Multitasking

As the media multitasking data were highly skewed towards 0 (Table 4.1), a GLMM was employed to examine changes in this behaviour as a function of counterbalanced task order (0-back First or 2-back First) and task difficulty (0-back versus 2-back). Task order and difficulty were included as fixed effects in the model, and participants were included as random effects. A Poisson distribution was specified for the skewed outcome variable (i.e., media multitasking). As shown in Table 4.2, there was no effect of order on media multitasking, although there was an effect of task difficulty. Importantly, there was also an interaction between order and task difficulty, revealing that participants who completed the 0-back first media multitasked more when completing the 2-back task (i.e., the second task) compared to the 0-back (i.e., the first task), while participants who completed the 2-back first media multitasked more during the 0-back (i.e., the second task) compared to the 2-back (i.e., the first task; Figure 4.1A). The tendency was for participants who played the video during the first task they completed to leave it on during the second task. Only three participants who played the video during the first task turned it off at some point during the second task. In all cases, this occurred when progressing from the 2-back task to the 0-back task. Figure 4.1B plots the media multitasking data as a function of experimental phase (the first versus the second task completed, regardless of task order condition) and task difficulty to better highlight this time-on-task effect.

Table 4.1.

Descriptive Statistics for Media Multitasking as a Function of Task Order and Difficulty.

Task Order	Task Difficulty	*M (SD)*	Median	Skew	Kurtosis
0-back first	0-back	62.23 (89.90)	0.00	0.95	-0.88
	2-back	87.09 (108.35)	0.00	0.48	-1.78
2-back first	0-back	71.28 (102.36)	0.00	0.79	-1.37
	2-back	41.77 (75.23)	0.00	1.44	0.42

Table 4.2.

GLMM Results for Media Multitasking as a Function of Task Order and Difficulty.

Fixed Effects	Estimate	SE	z	p
Intercept	-7.22	0.86	-8.45	< .001
Task order (2-back first)	0.11	0.96	0.11	.913
Task difficulty (2-back)	0.34	0.02	18.78	< .001
Task order* task difficulty	-0.87	0.03	-30.64	< .001

Note. Coefficients for the effect of task order are shown for the 2-back First condition (0-back First is the reference condition), and coefficients for task difficulty are shown for the 2-back (0-back is the reference condition). *P*-values are based on Wald z-tests comparing estimates against zero. $N = 164$.

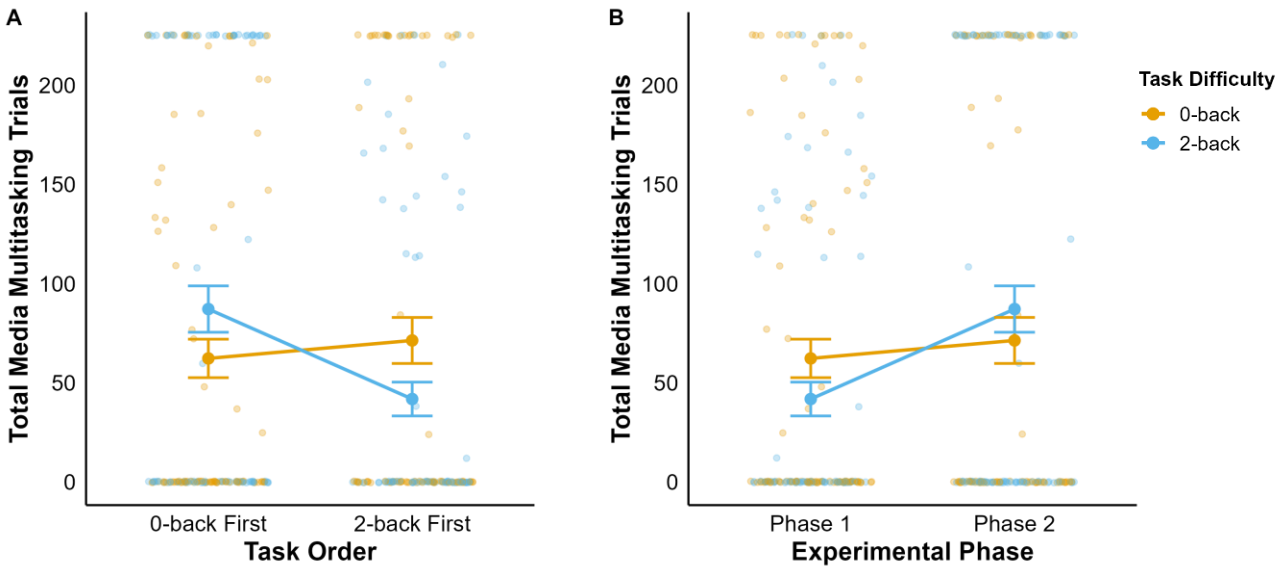


Figure 4.1. Average (±SE) number of trials spent media multitasking (A) as a function of task order and difficulty or (B) as a function of experimental phase and task difficulty. Individual data points are jittered to increase their visibility.

4.3.2 Boredom and Effort

Results of a mixed factorial ANOVA with task order as a between-participants factor and task difficulty as a within-participants factor revealed that there was no main effect of order on state boredom, $F(1, 162) = 0.12$, $\eta_p^2 < .01$, $p = .726$, although there was a main effect of task difficulty, $F(1, 162) = 8.58$, $\eta_p^2 = .05$, $p = .004$, such that ratings of boredom were higher during the 0-back task than the 2-back task (Figure 4.2A). The interaction between order and task difficulty did not reach significance, $F(1, 162) = 2.88$, $\eta_p^2 = .02$, $p = .091$. Regarding ratings of effort, there was no main effect of order, $F(1, 162) = 2.67$, $\eta_p^2 = .02$, $p = .104$; however, there was a main effect of task difficulty, $F(1, 162) = 74.76$, $\eta_p^2 = .32$, $p < .001$, with participants who completed the 0-back first reporting devoting more effort to the experimental tasks than

participants who completed the 2-back first (Figure 4.2B). There was no interaction between order and task difficulty, $F(1, 162) = 0.23$, $\eta_p^2 < .01$, $p = .635$.

4.3.3 Task Performance

Additional mixed factorial ANOVAs were conducted to ascertain whether the proportion of hits and false alarms varied as a function of task order (between-participants factor) or task difficulty (within-participants factor). There was no main effect of order, on proportion of hits $F(1, 162) = 0.08$, $\eta_p^2 < .01$, $p = .777$, although there was an effect of task difficulty, $F(1, 162) = 294.27$, $\eta_p^2 = .65$, $p < .001$ such that hit rates were higher during the 0-back compared to the 2-back (Figure 4.2C). There was no interaction between order and task difficulty, $F(1, 162) = 0.37$, $\eta_p^2 < .01$, $p = .543$. Concerning proportion of false alarms, there was no main effect of order, $F(1, 162) = 2.14$, $\eta_p^2 = .01$, $p = .146$. There was, however, a main effect of task difficulty, $F(1, 162) = 243.97$, $\eta_p^2 = .60$, $p < .001$, with proportion of false alarms being lower in the 0-back task compared to the 2-back task (Figure 4.2D). There was also an interaction between order and task difficulty, $F(1, 162) = 4.90$, $\eta_p^2 = .03$, $p = .028$. Although pairwise comparisons probing this interaction did not reveal significant differences in performance between task order conditions during the 0-back or 2-back tasks ($ps > .05$), the pattern displayed in Figure 4.2D suggests that this interaction was driven by a larger performance difference between conditions during the 2-back task. Specifically, participants who completed the 0-back task first performed numerically worse during the 2-back task than

participants who completed the 2-back task first. This difference was much smaller during the 0-back task.

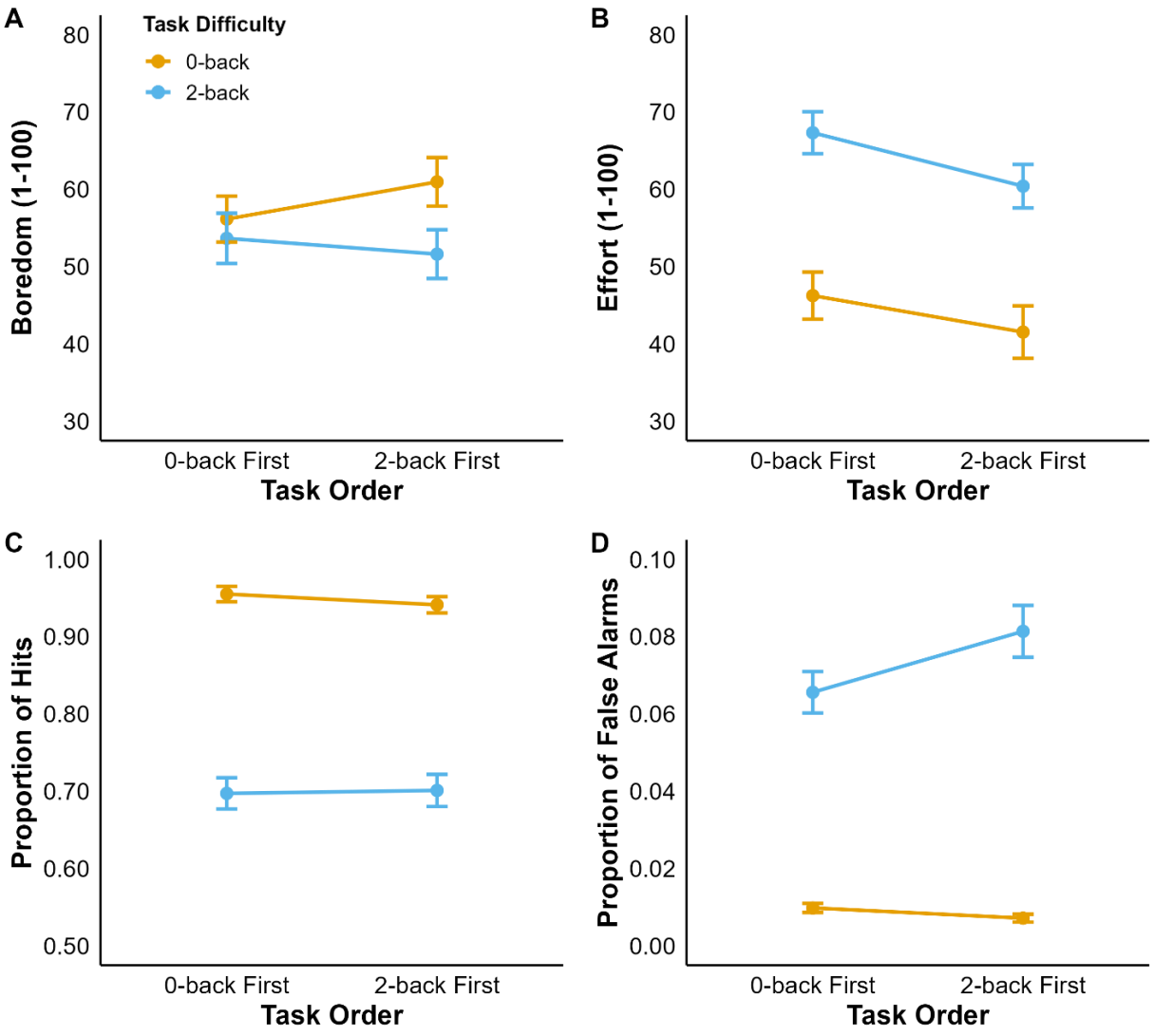


Figure 4.2. Mean (±SE) ratings of boredom (A) and effort (B), as well as proportion of hits (C) and proportion of false alarms (D) as a function of task order and difficulty.

4.3.4 Individual Difference Factors and Media Multitasking

Analyses involving the relations between the individual difference factors of interest and media multitasking were completed based on the total number of participants who provided complete responses to the respective measures. Descriptive statistics for each of the individual difference measures are provided in Table 4.3. Correlations between each of the individual difference measures can be found in Appendix C. Given the skewed distribution of the media multitasking data, Spearman's rank-order correlations were conducted to assess the relations between these measures and overall levels of media multitasking during the study, collapsing across order and task difficulty conditions. To assess whether these relations varied as a function of order or task difficulty, GLMMs were conducted with order, task difficulty and the individual difference factor of interest (one per model) included as fixed effects, and participant included as a random effect. The individual difference factors were standardized prior to their inclusion in the models to improve model convergence, and a Poisson distribution was specified for the outcome variable (i.e., media multitasking). Since the effects of order and task difficulty were established in previous sections, this section highlights the effects involving the individual difference factors of interest; however, the complete results of the GLMMs (including the unique effects of order and task difficulty) are provided in the tables below. Tests probing three-way interactions were adjusted using Tukey's HSD.

Table 4.3.

Descriptive Statistics for Individual Difference Factors

Variable	*M* (SD)	Median	Skew	Kurtosis	α
Attention-related cognitive errors (*N* = 156)	36.73 (8.39)	36.00	0.05	0.00	0.91
Attention lapses (*N* = 156)	41.92 (8.85)	43.00	-0.42	0.31	0.84
Spontaneous mind-wandering (*N* = 156)	4.71 (1.40)	4.75	-0.37	-0.39	0.89
Deliberate mind-wandering (*N* = 156)	4.61 (1.51)	4.75	-0.27	-0.58	0.91
Conscientiousness (*N* = 156)	4.73 (0.98)	4.67	-0.37	0.70	0.59
Self-control (*N* = 156)	36.87 (8.97)	36.00	0.40	-0.04	0.86
Boredom proneness (*N* = 156)	29.76 (9.84)	30.00	0.16	-0.38	0.89
Media Multitasking Index (*N* = 59)	2.95 (1.76)	2.60	0.93	1.19	-
Short Media Multitasking Measure (*N* = 161)	2.37 (0.64)	2.44	0.20	-0.62	0.87

Note. Cronbach's alpha is not provided for scores on the Media Multitasking Index, as this measure does not rely solely on Likert-type responses.

4.3.4.1 Attention-Related Measures

4.3.4.1.1 Attention-Related Cognitive Errors. No relation was found between attention-related cognitive errors and overall levels of media multitasking during the study, $r_s(154) = -.08$, $p = .303$. The GLMM revealed an interaction between scores on the Attention-

Related Cognitive Errors Scale and task difficulty (Table 4.4), such that attention-related cognitive errors were more strongly negatively associated with media multitasking during the 2-back than the 0-back (Figure 4.3A).

Table 4.4.

GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty, and Attention-Related Cognitive Errors Scores

Fixed Effects	Estimate	SE	z	p
Intercept	-7.36	0.88	-8.39	< .001
Task Order (2-back First)	0.28	1.00	0.28	.776
Task Difficulty (2-back)	0.35	0.02	18.60	< .001
Attention-Related Cognitive Errors	-0.20	0.69	-0.28	.781
Task Order * Task Difficulty	-0.87	0.03	-29.58	< .001
Task Order * Attention-Related Cognitive Errors	-0.01	1.02	-0.01	.989
Task Difficulty * Attention-Related Cognitive Errors	-0.11	0.02	-5.39	< .001
Task Order * Task Difficulty * Attention-Related Cognitive Errors	0.01	0.03	0.19	.849

Note. Coefficients for the effect of task order are shown for the 2-back First condition (0-back First is the reference condition), and coefficients for task difficulty are shown for the 2-back (0-back is the reference condition). *P*-values are based on Wald z-tests comparing estimates against zero. Scores on the Attention-Related Cognitive Errors scale are standardized. $N = 156$.

4.3.4.1.2 Attention Lapses. Concerning the Lapses-Only variant of the Mindful Attention Awareness Scale, scores did not correlate with overall levels of media multitasking during the study, $r_s(154) = -.13$, $p = .109$. However, in the GLMM, there was a significant interaction between task difficulty and attention lapses (Table 4.5), with greater attention lapses

more strongly predicting lower levels of media multitasking during the 2-back than the 0-back (Figure 4.3B).

Table 4.5.

GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Scores on the Lapses-Only variant of the Mindful Attention Awareness Scale.

Fixed Effects	Estimate	SE	z	p
Intercept	-7.30	0.90	-8.11	< .001
Task Order (2-back First)	0.27	1.01	0.27	.791
Task Difficulty (2-back)	0.35	0.02	17.95	< .001
Attention Lapses	-0.57	0.83	-0.68	.496
Task Order * Task Difficulty	-0.86	0.03	-28.87	< .001
Task Order * Attention Lapses	0.32	1.08	0.30	.763
Task Difficulty * Attention Lapses	-0.06	0.02	-2.81	.005
Task Order * Task Difficulty * Attention Lapses	0.04	0.03	1.33	.182

Note. Coefficients for the effect of task order are shown for the 2-back First condition (0-back First is the reference condition), and coefficients for task difficulty are shown for the 2-back (0-back is the reference condition). *P*-values are based on Wald z-tests comparing estimates against zero. Scores on the Lapses-Only variant of the Mindful Attention Awareness Scale (referred to in the table as "Attention Lapses") are standardized. $N = 156$.

4.3.4.1.3 Spontaneous and Deliberate Mind-Wandering. Scores on the Spontaneous Mind-Wandering Scale were not associated with overall levels of media multitasking during the study, $r_s(154) = -.14$, $p = .085$. Results of the GLMM showed that there was a significant interaction between spontaneous mind-wandering and task difficulty. There was also an interaction between spontaneous mind-wandering, order and task difficulty (Table 4.6). Specifically, for those who completed the 0-back task first, spontaneous mind-wandering was

more strongly negatively related to media multitasking during the 2-back compared to the 0-back, estimate = -0.05, SE = 0.01, z = -3.69, p = .001 (Figure 4.3C).

Table 4.6.

GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Scores on the Spontaneous Mind-Wandering Scale

Fixed Effects	Estimate	SE	z	p
Intercept	-7.32	0.88	-8.36	< .001
Task Order (2-back First)	0.28	1.01	0.28	.782
Task Difficulty (2-back)	0.38	0.02	19.67	< .001
Spontaneous Mind-Wandering	-0.25	0.70	-0.35	.726
Task Order * Task Difficulty	-0.89	0.03	-29.61	< .001
Task Order * Spontaneous Mind-Wandering	-0.26	1.05	-0.25	.804
Task Difficulty * Spontaneous Mind-Wandering	0.07	0.02	3.69	< .001
Task Order * Task Difficulty * Spontaneous Mind-Wandering	-0.12	0.03	-3.92	< .001

Note. Coefficients for the effect of task order are shown for the 2-back First condition (0-back First is the reference condition), and coefficients for task difficulty are shown for the 2-back (0-back is the reference condition). *P*-values are based on Wald z-tests comparing estimates against zero. Scores on the Spontaneous Mind-Wandering Scale are standardized. N = 156.

Regarding the Deliberate Mind-Wandering Scale, more frequent deliberate mind-wandering was associated with greater overall levels of media multitasking during the study, $r_s(154) = .20$, $p = .013$. Moreover, the GLMM indicated that there was a significant interaction between deliberate mind-wandering and task difficulty (Table 4.7) such that a greater frequency

of deliberate mind-wandering was more strongly associated with greater media multitasking during the 2-back than the 0-back (Table 4.7; Figure 4.3D).

Table 4.7.

GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Scores on the Deliberate Mind-Wandering Scale.

Fixed Effects	Estimate	SE	*z*	*p*
Intercept	-7.24	0.91	-7.96	< .001
Task Order (2-back First)	0.41	1.04	0.40	.691
Task Difficulty (2-back)	0.35	0.02	18.18	< .001
Deliberate Mind-Wandering	0.61	0.79	0.77	.441
Task Order * Task Difficulty	-0.87	0.03	-28.96	< .001
Task Order * Deliberate Mind-Wandering	0.26	1.21	0.22	.826
Task Difficulty * Deliberate Mind-Wandering	0.04	0.02	2.57	.010
Task Order * Task Difficulty * Deliberate Mind-Wandering	0.01	0.03	0.23	.820

Note. Coefficients for the effect of task order are shown for the 2-back First condition (0-back First is the reference condition), and coefficients for task difficulty are shown for the 2-back (0-back is the reference condition). *P*-values are based on Wald *z*-tests comparing estimates against zero. Scores on the Deliberate Mind-Wandering Scale are standardized. $N = 156$.

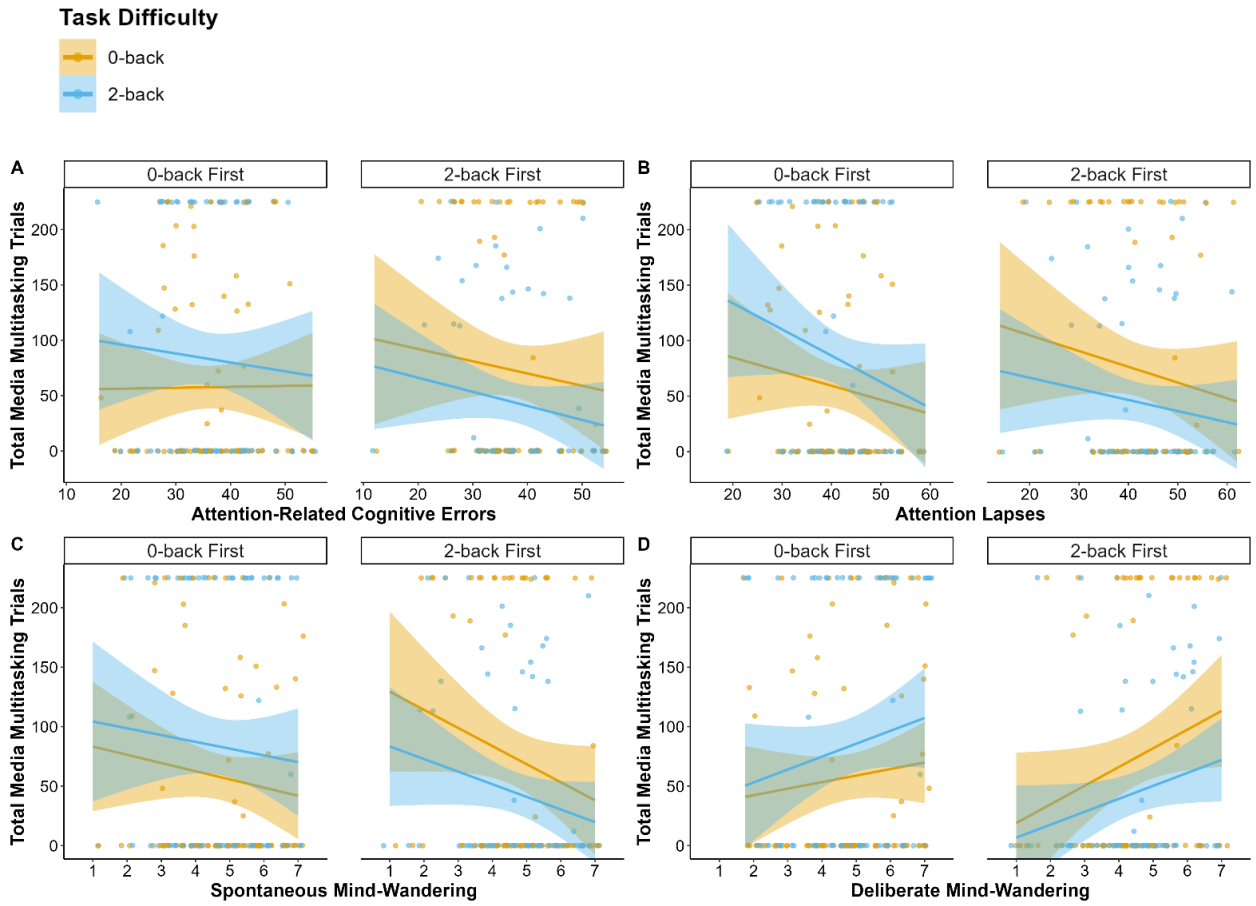


Figure 4.3. Scatterplots depicting relations between scores on the attention-related trait measures and media multitasking during the 0-back and 2-back based on task order. Data points are jittered to increase their visibility. Regression lines are fitted to the data and shading represents 95% confidence intervals.

4.3.4.2 Self-Regulatory Measures

4.3.4.2.1 Conscientiousness. Conscientiousness was not associated with overall levels of media multitasking throughout the study, $r_s(154) = .00$, $p = .958$. Results of the GLMM revealed an interaction between conscientiousness and task difficulty as well as an interaction between order, task difficulty and conscientiousness (Table 4.8). Conscientiousness was associated with greater media multitasking among those who completed the 0-back first, with

this relation being more evident when they completed the 2-back than the 0-back, estimate = -0.12, *SE* = 0.02, z = -5.86, $p < .001$. Among those who completed the 2-back first, conscientiousness was more strongly negatively associated with this behaviour during the 2-back task, estimate = 0.15, *SE* = 0.02, z = 6.66, $p < .001$ (Figure 4.4A).

Table 4.8.

GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Conscientiousness Scores.

Fixed Effects	Estimate	SE	z	p
Intercept	-7.35	0.88	-8.39	< .001
Task Order (2-back First)	0.25	1.00	0.25	.803
Task Difficulty (2-back)	0.35	0.02	18.46	< .001
Conscientiousness	0.17	0.67	0.26	.796
Task Order * Task Difficulty	-0.89	0.03	-29.86	< .001
Task Order * Conscientiousness	-0.45	1.05	-0.43	.666
Task Difficulty * Conscientiousness	0.11	0.02	5.86	< .001
Task Order * Task Difficulty * Conscientiousness	-0.26	0.02	-8.87	< .001

Note. Coefficients for the effect of task order are shown for the 2-back First condition (0-back First is the reference condition), and coefficients for task difficulty are shown for the 2-back (0-back is the reference condition). *P*-values are based on Wald z-tests comparing estimates against zero. Scores on the Conscientiousness Scale are standardized. $N = 156$.

4.3.4.2.2 Self-Control. Scores on the Brief Self-Control Scale did not correlate with overall levels of media multitasking during the study, $r_s(154) = -.06$, $p = .464$. Results of the GLMM revealed an interaction between task difficulty and self-control (Table 4.9), as well as an interaction between order, task difficulty and self-control. As shown in Figure 4.4B, among those who completed the 0-back first, self-control was related to greater media multitasking

while completing the 2-back, but less media multitasking while completing the 0-back, estimate = -0.02, *SE* = 0.00, z = -5.78, p < .001. Among those who completed the 2-back first, self-control was associated with less media multitasking during both tasks, with this relation being stronger during the 2-back compared to the 0-back, estimate = 0.02, *SE* = 0.00, z = 5.01, p < .001.

Table 4.9.

GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Scores on the Brief Self-Control Scale

Fixed Effects	Estimate	SE	z	p
Intercept	-7.35	0.87	-8.40	< .001
Task Order (2-back First)	0.20	1.01	0.20	.840
Task Difficulty (2-back)	0.35	0.02	18.28	< .001
Self-Control	-0.04	0.62	-0.07	.944
Task Order * Task Difficulty	-0.90	0.03	-29.06	< .001
Task Order * Self-Control	-0.30	1.01	-0.29	.770
Task Difficulty * Self-Control	0.12	0.02	5.78	< .001
Task Order * Task Difficulty * Self-Control	-0.26	0.03	-7.51	< .001

Note. Coefficients for the effect of task order are shown for the 2-back First condition (0-back First is the reference condition), and coefficients for task difficulty are shown for the 2-back (0-back is the reference condition). *P*-values are based on Wald z-tests comparing estimates against zero. Scores on the Brief Self-Control Scale are standardized. *N* = 156.

4.3.4.2.3 Boredom Proneness. Boredom proneness did not correlate with overall levels of media multitasking during the study, $r_s(154) = -.11$, $p = .174$. Results of the GLMM revealed a significant interaction between boredom proneness and task difficulty, as well as an interaction

between boredom proneness, order and task difficulty (Table 4.10). As shown in Figure 4.4C, while there was little relation between boredom proneness and media multitasking among those who completed the 2-back first, higher boredom proneness predicted less media multitasking among those who completed the 0-back first. This relation was stronger during the 2-back compared to the 0-back, estimate = 0.01, $SE = 0.00$, $z = 5.36$, $p < .001$.

Table 4.10.

GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Scores on the Short Boredom Proneness Scale

Fixed Effects	Estimate	SE	z	p
Intercept	-7.27	0.93	7.79	< .001
Task Order (2-back First)	0.25	1.02	0.24	.808
Task Difficulty (2-back)	0.32	0.02	15.83	< .001
Boredom Proneness	-0.81	0.87	-0.93	.352
Task Order * Task Difficulty	-0.83	0.03	-27.22	< .001
Task Order * Boredom Proneness	0.90	1.09	0.823	.411
Task Difficulty * Boredom Proneness	-0.11	0.02	-5.36	< .001
Task Order * Task Difficulty * Boredom Proneness	0.09	0.03	2.51	.012

Note. Coefficients for the effect of task order are shown for the 2-back First condition (0-back First is the reference condition), and coefficients for task difficulty are shown for the 2-back (0-back is the reference condition). *P*-values are based on Wald z-tests comparing estimates against zero. Scores on the Short Boredom Proneness Scale are standardized. $N = 156$.

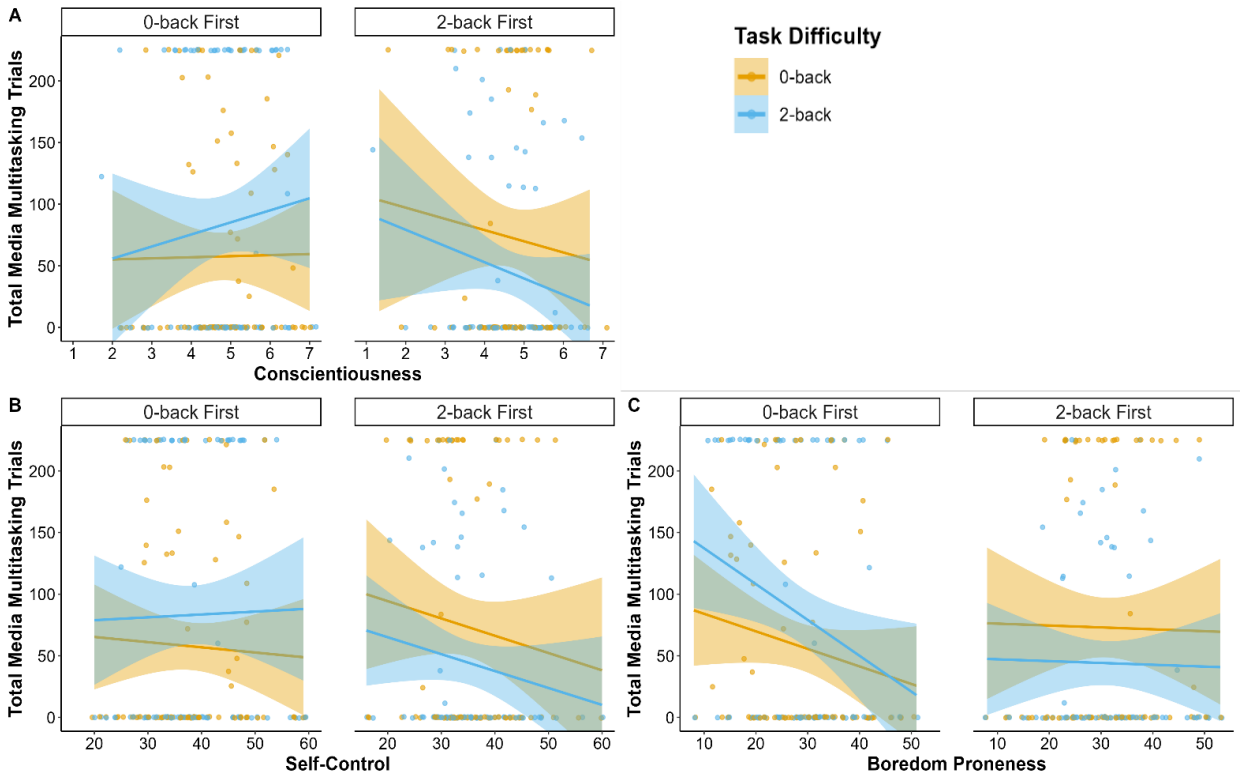


Figure 4.4. Scatterplots depicting the relations between scores on the measures of conscientiousness, self-control and boredom proneness and media multitasking during the 0-back and 2-back based on task order. Data points are jittered to increase their visibility. Regression lines are fitted to the data and shading represents 95% confidence intervals.

4.3.4.3 Media Multitasking Questionnaires

4.3.4.3.1 Media Multitasking Index. As only 59 participants (72 in the 0-back First condition and 46 in the 2-back First condition) provided complete responses on the Media Multitasking Index, results involving this measure should be interpreted with caution. Scores on the Media Multitasking Index were unrelated to participants' overall levels of media multitasking during the study, $r_s(57) = .18$, $p = .181$.

Results of the GLMM (Table 4.11) indicated that scores on the Media Multitasking Index did not predict media multitasking during the study; however, as shown in Figure 4.5A,

there was a (nonsignificant) trend whereby higher scores on the Media Multitasking Index were associated with greater media multitasking during the study.

Table 4.11.

GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Media Multitasking Index Scores.

Fixed Effects	Estimate	SE	z	p
Intercept	-0.45	1.72	-0.26	.795
Task Order (2-back First)	-4.33	1.73	-2.50	.013
Task Difficulty (2-back)	0.33	0.02	13.69	< .001
Media Multitasking Index	2.04	1.46	1.40	.162
Task Order * Task Difficulty	-0.73	0.05	-14.54	< .001
Task Order * Media Multitasking Index	-1.36	1.89	-0.72	.471
Task Difficulty * Media Multitasking Index	0.01	0.03	0.54	.590
Task Order * Task Difficulty * Media Multitasking Index	-0.03	0.04	-0.76	.449

Note. Coefficients for the effect of task order are shown for the 2-back First condition (0-back First is the reference condition), and coefficients for task difficulty are shown for the 2-back (0-back is the reference condition). *P*-values are based on Wald z-tests comparing estimates against zero. $N = 59$.

4.3.4.3.2 Short Media Multitasking Measure. A Spearman's rank-order correlation revealed no significant association between scores on the Short Media Multitasking Measure and media multitasking during the study, $r_s(159) = .00$, $p = .993$. Interestingly, however, the results of the GLMM showed that there was a significant interaction between order, task difficulty and scores on the Short Media Multitasking Measure (Table 4.12). As illustrated in Figure 4.5B, both task order conditions exhibited opposing relations between scores on the Short Media

Multitasking Measure and in-study media multitasking. In the 0-back First condition, higher scores on the Short Media Multitasking Measure were associated with greater media multitasking. In contrast, in the 2-back First condition, higher scores were associated with *less* media multitasking, with this relation being stronger during the 2-back task compared to the 0-back task, estimate = 0.26, $SE = 0.04$, $z = 7.15$, $p < .001$.

Table 4.12.

GLMM Results for Media Multitasking as a Function of Task Order, Task Difficulty and Short Media Multitasking Measure Scores.

Fixed Effects	Estimate	SE	*z*	*p*
Intercept	-7.15	0.88	-8.15	< .001
Task Order (2-back First)	-0.01	0.98	-0.01	.996
Task Difficulty (2-back)	0.33	0.02	18.54	< .001
Short Media Multitasking Measure	0.21	0.71	0.30	.767
Task Order * Task Difficulty	-0.88	0.03	-30.45	< .001
Task Order * Short Media Multitasking Measure	-0.34	0.99	-0.34	.732
Task Difficulty * Short Media Multitasking Measure	0.02	0.02	1.05	.292
Task Order * Task Difficulty * Short Media Multitasking Measure	-0.18	0.03	-6.28	< .001

Note. Coefficients for the effect of task order are shown for the 2-back First condition (0-back First is the reference condition), and coefficients for task difficulty are shown for the 2-back (0-back is the reference condition). *P*-values are based on Wald *z*-tests comparing estimates against zero. $N = 161$.

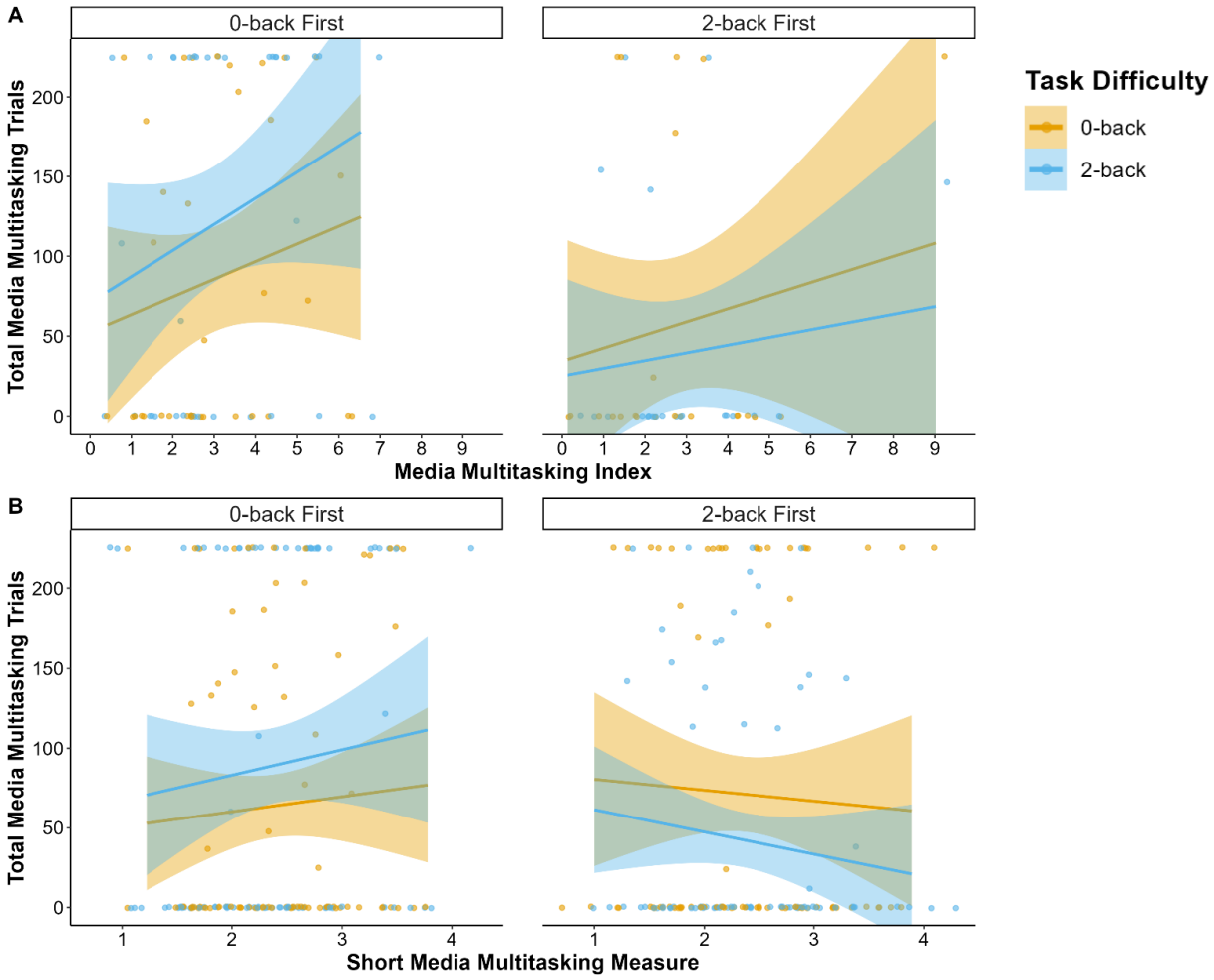


Figure 4.5. Scatterplots depicting the relations between scores on the Media Multitasking Index (A) and the Short Media Multitasking Measure (B) and media multitasking during the 0-back and 2-back based on task order. Data points are jittered to increase their visibility. Regression lines are fitted to the data and shading represents 95% confidence intervals.

4.3.5 Extra-Experimental Media Multitasking

Responses to the post-task question assessing whether participants engaged with content outside the experimental context were examined to better understand participants' behaviours during the study. In all, 39.02% of participants reported engaging with other media-related content during the experiment, while 6.10% reported engaging with media-unrelated content

during the study. The remaining 55.88% of participants did not report engaging in activities outside the experimental context.

As multitasking with content outside the experimental context may be considered a more ecologically valid form of media multitasking, exploratory analyses were conducted to investigate whether scores on the individual difference measures differed based on participants' responses to the post-task question. Participants' responses to the question were re-coded to form a binary variable with reports of engaging with content unrelated to the experiment categorized as "Extra-Experimental MMT," and reports of refraining from engaging with other content coded as "No MMT." A series of independent samples *t*-tests were then conducted comparing scores on each of the individual difference measures between the Extra-Experimental MMT and No MMT groups[4].

No significant differences were observed for scores on the Attention-Related Cognitive Errors Scale, Deliberate Mind-Wandering Scale, Conscientiousness Scale and Brief Self-Control Scale ($ps > .05$). However, scores on the Lapses-Only variant of the Mindful Attention Awareness Scale were higher among those who reported engaging in extra-experimental media multitasking ($M = 43.97$, $SD = 7.70$) compared to those who did not ($M = 40.21$, $SD = 9.41$), $t(154) = 2.70$, $p = .008$, $d = 0.43$. The same was true of scores on the Spontaneous Mind-Wandering Scale ($M_{Extra\text{-}Experimental\ MMT} = 4.98$, $SD_{Extra\text{-}Experimental\ MMT} = 1.41$, $M_{No\ MMT} = 4.50$, $SD_{No\ MMT} = 1.36$), $t(154) = 2.15$, $p = .033$, $d = 0.35$, as well as the Short Boredom Proneness Scale ($M_{Extra\text{-}}$

[4] While this approach of analyzing data for participants who did and did not engage in extra-experimental media multitasking aligns with the approach taken in Chapter 3, it differs from that used in Chapter 2, which compared participants who reported engaging with media-related activities during the study to those who did not engage in multitasking of any kind (i.e., with the optional video or activities outside the experimental context). Results based on the method used in Chapter 2 are presented in Appendix C.

$_{Experimental\ MMT}$ = 31.80, $SD_{Extra\text{-}Experimental\ MMT}$ = 9.95, $M_{No\ MMT}$ = 28.06, $SD_{No\ MMT}$ = 9.47), $t(154) = 2.40$, $p = .017$, $d = 0.39$. Scores on the Media Multitasking Index ($M_{Extra\text{-}Experimental\ MMT} = 3.52$, $SD_{Extra\text{-}Experimental\ MMT} = 1.99$, $M_{No\ MMT} = 2.59$, $SD_{No\ MMT} = 1.52$), $t(57) = 2.02$, $p = .048$, $d = 0.54$, and the Short Media Multitasking Measure ($M_{Extra\text{-}Experimental\ MMT} = 2.52$, $SD_{Extra\text{-}Experimental\ MMT} = 0.63$, $M_{No\ MMT} = 2.25$, $SD_{No\ MMT} = 0.62$), $t(159) = 2.73$, $p = .007$, $d = 0.43$, were also higher among participants who reported multitasking compared to those who did not. Scores for the individual difference variables that significantly differed as a function of post-task response are displayed in Figure 4.6. Results remained unchanged when using the method of analyzing responses to the extra-experimental media multitasking question employed in Chapter 2 (Appendix C).

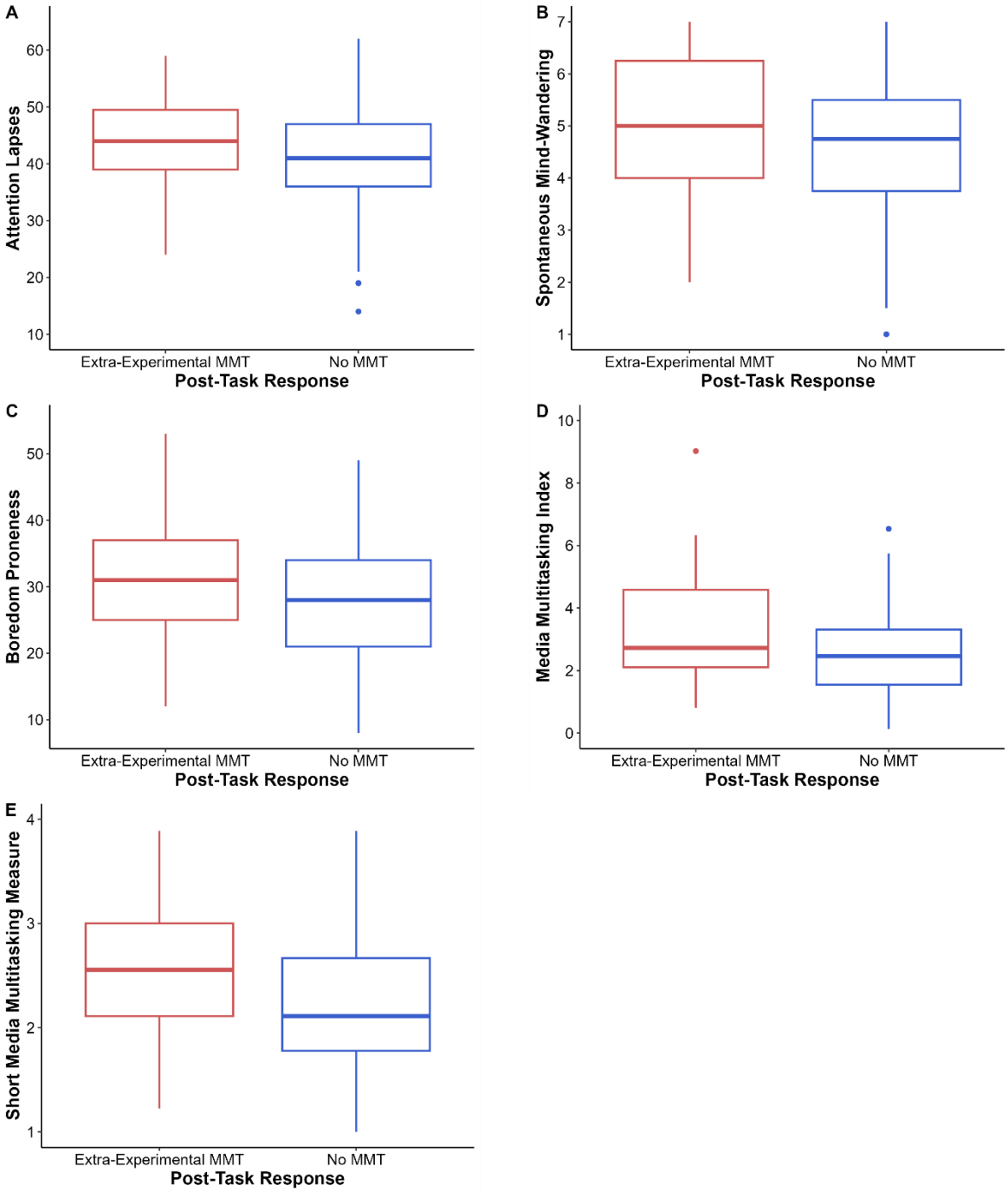


Figure 4.6. Boxplots depicting scores on individual difference factors as a function of responses to the post-task media multitasking question. The Extra-Experimental MMT group consists of participants who engaged in activities outside the experimental context while completing the study. The No MMT group consists of participants who only engaged with content relevant to the experiment. Plots are only shown for measures which differed significantly as a function of responses to the post-task question (*ps* < .05).

4.4 Discussion

This study contributes to the relatively small body of research examining the joint role of individual differences and contextual factors in media multitasking. The low-demand task was associated with higher levels of state boredom, lower ratings of effort, and better performance compared to the high-demand task, consistent with findings from Ralph and colleagues (2020) who employed the same two tasks. While Ralph and colleagues observed higher rates of media multitasking during the low- versus high-demand task, the effect of task difficulty on media multitasking in the present study was dependent on task order. That is, participants media multitasked more during whichever task they completed second. This finding aligns with the temporal increases in media multitasking observed in the previous chapters and in work by Wammes and colleagues (2019). Moreover, it suggests that time-on-task may be more influential in one's decision to media multitask than task difficulty.

Regarding the relations between individual difference factors and media multitasking, patterns were less straightforward. Interestingly, except for deliberate mind-wandering which was correlated with higher levels of in-study media multitasking, relations between the individual difference measures and media multitasking only emerged after considering their interactions with task difficulty and/or task order. This finding suggests that, in addition to task difficulty, task order represents an important contextual influence on media multitasking.

Relations between the individual difference factors and media multitasking varied considerably across levels of these two contextual variables, and often in directions that ran contrary to hypotheses. A possible explanation for these unanticipated relations comes from responses to the post-task question assessing extra-experimental media multitasking. Scores on

many of the individual difference measures that showed unexpected relations (i.e., attention lapses, spontaneous mind-wandering, boredom proneness, the Media Multitasking Index and the Short Media Multitasking Measure) were found to be higher among those who reported engaging in extra-experimental media multitasking compared to those who did not. This raises the possibility that participants scoring high on these measures were more likely to engage in more personally relevant forms of media multitasking rather than engaging with the video provided within the experimental task.

While it may be tempting to interpret each interaction effect in the present study, further research is needed to assess the reliability of these effects, particularly in more controlled laboratory settings where the opportunity to engage with content outside the experimental context is removed. Nevertheless, the present findings support the broader theoretical framework underlying this study by showing that both individual difference factors and contextual factors play an important role in media multitasking, and that one's likelihood of media multitasking at a given moment likely depends on specific combinations of variables within these two classes of factors.

Chapter 5: Do individual difference factors predict media multitasking when context is held constant over time?

5.1 Introduction

An assumption that follows from the notion that media multitasking arises from an interplay between relatively stable individual difference factors and more variable contextual factors is that, when certain key contextual variables are held constant, individuals should show consistent media multitasking behaviours over time. Furthermore, in such cases, media multitasking should be largely driven by stable individual difference factors. The present chapter explored this assumption by having participants complete the 1-back media multitasking paradigm on two occasions spaced approximately one week apart. The individual difference measures explored in Chapter 4 (i.e., traits related to attention and self-regulation as well as self-reported media multitasking tendencies) were then examined in relation to in-study media multitasking. To maintain consistency across sessions and remove extra-experimental media multitasking as a possibility, this study was conducted in the laboratory. This allowed key contextual variables, such as participants' physical environment, opportunities to media multitask and the assigned tasks, to remain fixed across sessions. The hypotheses were twofold. First, rates of media multitasking should be positively correlated across sessions. Second, media multitasking at both sessions should be predicted by traits related to inattention and low self-regulation, as well as higher scores on the media multitasking questionnaires.

5.2 Methods

5.2.1 Participants

A total of 253 undergraduate students from the University of Waterloo partook in the study. Participants were required to complete the second session within five days to two weeks of completing the first session. This timeline was chosen to provide participants with sufficient flexibility to schedule both sessions, but not so much time that it would introduce substantial variability in the interval between sessions or lead to a high rate of attrition due to scheduling too far in advance. Fifty-nine participants were removed for failing to attend both sessions, and an additional participant was excluded for continuously holding down the video toggle key over many consecutive trials of the task. This resulted in several recorded video toggles per trial and made it unclear as to whether they intended the video to be turned on or off for each trial. Applying the same performance filters as in previous chapters (i.e., removing participants with less than 30% hits and more than 20% false alarms) resulted in the removal of an additional 15 participants. A final two participants were removed for having implausible survey responses (e.g., indicating that they spent 24 hours per day engaging with multiple forms of media). The final sample consisted of 176 participants (137 women, 25 men, 6 gender queer/gender non-conforming/gender non-binary, 8 no response), with an age range of 17 to 43 years old (M_{age} = 19.75, SD_{age} = 2.79).

5.2.2 1-back Task and Media Multitasking

At each session, participants completed 486 trials (18 practice trials, 468 experimental trials) of the 1-back media multitasking paradigm (Drody et al., 2022; Ralph et al., 2020, 2021). The only difference between sessions was the content of the optional video, as familiarity with

the video would likely be an important determinant of whether participants chose to play it. At each session, participants either viewed a TED Talk about magic ("Brain Magic) or one about New Yorker Cartoons ("Anatomy of a New Yorker Cartoon"). Video order was counterbalanced across participants (Brain Magic First n = 90, New Yorker First n = 86).

5.2.3 Video and Task Enjoyment

Since the New Yorker video had never been used in the media multitasking paradigm, it was important to explore whether participant's experiences differed based on the videos provided at each session. Therefore, at each session, participants reported their enjoyment of the 1-back as well as the video (provided they watched it) following completion of the 1-back task. The 1-back enjoyment question asked, "How much did you enjoy completing the 1-back task," while the video enjoyment question asked, "If you watched the optional video, how much did you enjoy the video?". Responses were provided on a Likert scale with options ranging from 1 (I did not enjoy it at all) to 7 (I enjoyed it very much). An additional option of "N/A – I did not watch the optional video" was provided for the video enjoyment question.

5.2.4 Post-Task Survey

At each session, after responding to the video and task enjoyment questions, participants completed a survey containing the Attention-Related Cognitive Errors Scale (Cheyne et al., 2006), Mindful Attention Awareness Scale – Lapses Only (Carriere et al., 2008), Spontaneous and Deliberate Mind-Wandering Scales (Carriere et al., 2013), Conscientiousness subscale of the Short Big Five Inventory (Lang et al., 2011), Brief Self-Control Scale (Tangney et al., 2004), and Short Boredom Proneness Scale (Struk et al., 2017). Also included in the survey were the Media

Multitasking Index (Ophir et al., 2009) and the Short Media Multitasking Measure (Baumgartner et al., 2017). Importantly, conscientiousness scores were collected separately from this study as part of the Department of Psychology's Mass Testing Survey. Therefore, unlike the other individual difference factors, conscientiousness was only measured on one occasion.

5.2.5 Data Analyses

Correlations were first conducted assessing the degree of consistency in participants media multitasking behaviours across sessions. Next, to provide context for understanding participants' experiences at each of the sessions, participants' performance on the 1-back as well as their enjoyment of the 1-back and optional videos were assessed using mixed factorial ANOVAs with video order (Brain Magic First or New Yorker First) as a between-participants factor and session (first or second session) as a within-participants factor. Finally, relations between the individual difference measures and media multitasking were analyzed.

5.3 Results

5.3.1 Media Multitasking

As the media multitasking data were highly skewed, a Spearman's rank-order correlation was used to assess the relation between media multitasking at the first (M = 125.00, SD = 175.40, Mdn = 0.00, skew = 0.92, kurtosis = -0.88) and second sessions (M = 185.85, SD = 208.40, Mdn = 16.00, skew = 0.39, kurtosis = -1.70). Rates of media multitasking were moderately positively correlated across sessions, $r_s(174) = .41$, $p < .001$ (Figure 5.1A).

A GLMM was used to examine whether media multitasking varied as a function of video order and session. Order and session were included as fixed effects in the model, and participant

was included as a random effect. A Poisson distribution was specified for the outcome variable. Results of the model are presented in Table 5.1. There was a main effect of session as well as an interaction between session and order. While both video order conditions exhibited a significant increase in media multitasking across sessions, those who viewed the Brain Magic video first exhibited a steeper increase in media multitasking across sessions, estimate = -0.57, SE = 0.01, p < .001, than those who viewed the New Yorker video first, estimate = -0.21, SE = 0.01, p < .001 (Figure 5.1B).

Table 5.1.

GLMM Results for Media Multitasking as a Function of Session and Video Order

Fixed Effects	Estimate	SE	z	p
Intercept	2.00	0.46	4.34	< .001
Video Order (New Yorker First)	-0.26	0.66	-0.39	.695
Session (Second Session)	0.57	0.01	46.76	< .001
Video Order * Session	-0.36	0.02	-20.62	< .001

Note. Coefficients for the effect of video order are shown for the New Yorker First condition (the Brain Magic First condition is the reference condition), and coefficients for the effect of session are shown for the second session (the first session is the reference condition). *P*-values are based on Wald z-tests comparing estimates against zero. N = 176.

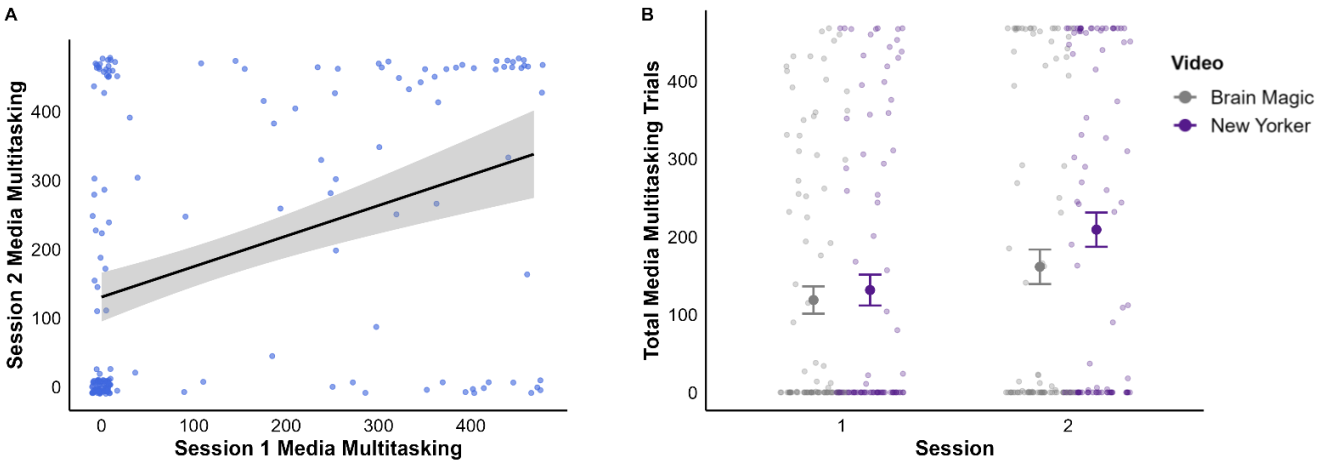


Figure 5.1. (A) Scatterplot depicting the relation between the total trials participants spent media multitasking at Session 1 and media multitasking at Session 2. (B) Graph depicting the total number of trials participants spent media multitasking at each timepoint and for each video. Large points indicate means, while error bars represent +/- 1 standard error of the mean. Individual data points are jittered to increase their visibility.

5.3.2 Performance

Proportion of hits did not differ based on video order, $F(1, 174) = 3.23$, $p = .074$, $\eta p^2 = .02$, although it differed across sessions, $F(1, 174) = 37.80$, $p < .001$, $\eta p^2 = .18$. That is, hit rates were lower during the second session compared to the first. There was also an interaction between order and session, $F(1, 174) = 5.68$, $p = .018$, $\eta p^2 = .03$, with proportion of hits dropping more steeply in the New Yorker First condition compared to the Brain Magic First condition (Figure 5.2A). Regarding proportion of false alarms, there was no main effect of order, $F(1, 174) = 0.47$, $p = .492$, $\eta p^2 < .01$, no main effect of session, $F(1, 174) = 0.17$, $p = .678$, $\eta p^2 < .01$, and no interaction between order and session, $F(1, 174) = 0.60$, $p = .441$, $\eta p^2 < .01$ (Figure 5.2B).

5.3.3 Task and Video Enjoyment

Ratings of task and video enjoyment are depicted in Figure 5.2C. Regarding ratings of task enjoyment, there was no main effect of order, $F(1, 174) = 0.00$, $p = .955$, $\eta p^2 < .01$, or session, $F(1, 174) = 1.44$, $p = .232$, $\eta p^2 = .01$, nor was there an interaction between order and session, $F(1, 174) = 0.06$, $p = .807$, $\eta p^2 < .01$. Analyses regarding ratings of video enjoyment omitted two participants who failed to respond to the question as well as 108 participants who indicated that the question was not applicable at one or both sessions because they did not play the video. There was no main effect of order on video enjoyment, $F(1, 66) = 0.36$, $p = .548$, $\eta p^2 = .01$ and no main effect of session, $F(1, 66) = 2.86$, $p = .095$, $\eta p^2 = .04$. There was, however, a significant interaction between order and session, $F(1, 66) = 8.09$, $p = .006$, $\eta p^2 = .11$. Ratings of video enjoyment did not significantly differ based on video order during the first session ($M_{Brain\ Magic\ First} = 5.25$, $SD_{Brain\ Magic\ First} = 1.42$, $M_{New\ Yorker\ First} = 4.75$, $SD_{New\ Yorker\ First} = 1.55$), $t(66) = 1.39$, $p = .169$; however, participants in the Brain Magic First condition rated the video at the second session (for them, Anatomy of a New Yorker Cartoon) less highly ($M = 4.97$, $SD = 1.80$) than participants in the New Yorker First condition, who viewed the Brain Magic video at this session ($M = 5.84$, $SD = 1.65$), $t(66) = -2.08$, $p = .042$ (Figure 5.2D).

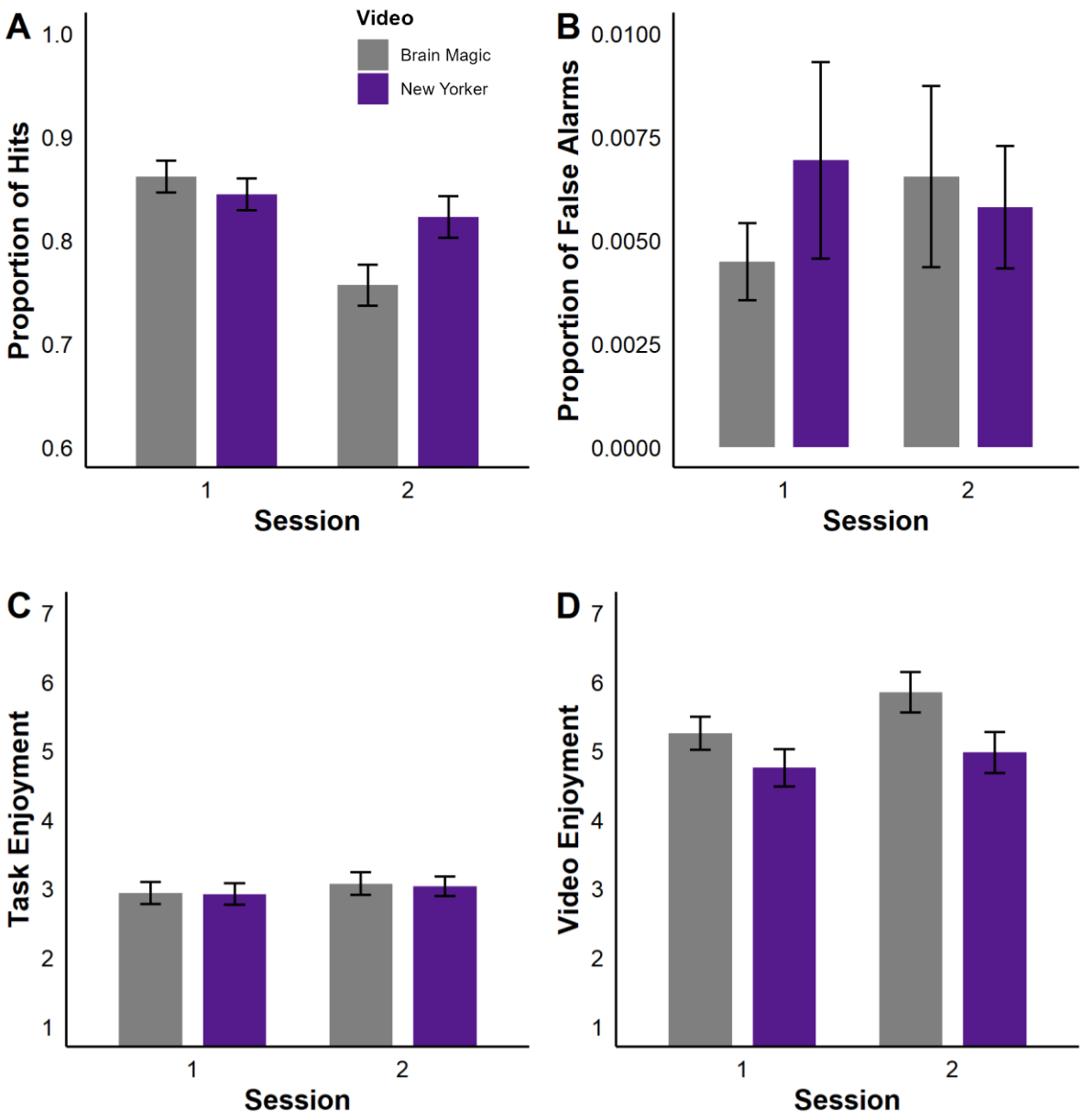


Figure 5.2. Bar graphs depicting mean (±SE) (A) proportion of hits, (B) proportion of false alarms, (C) task enjoyment, and (D) video enjoyment as a function of video and session. Note that the colours in this graph represent the video participants viewed rather than their assigned video order condition.

5.3.4 Individual Difference Factors and Media Multitasking

Table 5.2 presents descriptive statistics for the individual difference measures at both sessions as well as the degree to which they were correlated across sessions. Responses on all the individual difference measures, except for conscientiousness, which was only assessed at one timepoint, were strongly correlated over time. Correlations between each of the trait measures can be found in Appendix D. Analyses concerning the relations between the individual difference factors and in-study media multitasking were conducted using only participants who provided complete responses on each respective measure. For each participant, scores on the individual difference measures were averaged across sessions to provide a single data point for use in the analyses. To examine these relations, a series of GLMMs were employed with session, one of the individual difference measures (e.g., attention-related cognitive errors), and their interaction, entered as fixed effects. To control for the influence of video order, this variable was included as an additional fixed effect in the models. Participant was entered as a random effect, and a Poisson distribution was specified for the outcome variable (i.e., media multitasking during the study).

Table 5.2.

Descriptive Statistics and Between-Session Correlations for Individual Difference Measures

Variable	Session 1					Session 2					*r*
	M (SD)	Mdn	Skew	Kurtosis	α	*M* (SD)	Mdn	Skew	Kurtosis	α	
Attention-related cognitive errors (*N* = 173)	38.15 (7.93)	37.00	0.25	-0.14	0.87	37.16 (8.21)	37.00	-0.07	-0.01	0.90	.77***
Attention lapses (*N* = 168)	44.60 (9.77)	45.00	0.01	-0.30	0.87	43.72 (9.83)	44.00	-0.08	-0.38	0.88	.54***
Deliberate mind-wandering (*N* = 176)	4.55 (1.51)	5.00	-0.18	-0.46	0.90	4.68 (1.52)	5.00	-0.33	-0.51	0.92	.73***
Spontaneous mind-wandering (*N* = 176)	5.04 (1.50)	5.00	-0.55	-0.21	0.83	4.86 (1.45)	5.00	-0.49	0.10	0.87	.73***
Conscientiousness (*N* = 164)	4.75 (0.89)	4.67	-0.06	-0.58	0.53	-	-	-	-	-	-
Self-control (*N* = 169)	38.86 (8.55)	39.00	0.03	-0.52	0.85	38.43 (8.46)	38.00	0.24	-0.17	0.85	.91***
Boredom proneness (*N* = 170)	27.90 (10.08)	27.00	0.33	-0.44	0.89	27.33 (10.04)	25.50	0.46	-0.51	0.90	.90***
Media Multitasking Index (*N* = 39)	2.69 (1.20)	2.59	0.69	1.30	-	2.43 (1.08)	2.35	0.38	-0.71	-	.68***
Short Media Multitasking Measure (*N* = 171)	2.48 (0.63)	2.44	0.08	-0.77	0.85	2.45 (0.64)	2.33	0.20	-0.76	0.87	.77***

Note. Because conscientiousness scores were collected through the Mass Testing Survey, which only provided one measurement timepoint, these data are not shown for each session. Cronbach's alphas are not shown for the Media Multitasking Index, as this measure does not rely solely on Likert-type responses.

5.3.4.1 Attention-Related Measures

Table 5.3 presents the results of the GLMMs involving the attention-related measures. The relations between these measures and media multitasking are visually depicted in Figure 5.3 based on the estimates provided by the models. Regarding attention-related cognitive errors, there was an interaction with session, such that attention-related cognitive errors more strongly predicted media multitasking during the second session compared to the first. Attention lapses and spontaneous mind-wandering were unrelated to media multitasking during the study. However, the model involving deliberate mind-wandering revealed an interaction between deliberate mind-wandering and session such that greater deliberate mind-wandering was associated with higher levels of media multitasking, with this relation being more pronounced during the second session relative to the first session.

Table 5.3.

GLMM Results for Media Multitasking as a Function of Session and the Attention-Related Measures, Controlling for Video Order

Predictor of Interest	Fixed Effects	Estimate	SE	z	p
Attention-Related Cognitive Errors Scale (N = 173)	Intercept	2.08	0.47	4.46	< .001
	Video order (New Yorker First)	-0.45	0.67	-0.67	.502
	Session (Second Session)	0.41	0.01	45.68	< .001
	Attention-related cognitive errors	0.40	0.33	1.21	.228
	Session * Attention-related cognitive errors	-0.02	0.01	-2.41	.016
Mindful Attention Awareness Scale – Lapses Only (N = 168)	Intercept	2.09	0.47	4.42	< .001
	Video order (New Yorker First)	-0.47	0.69	-0.68	.495
	Session (Second Session)	0.44	0.01	48.75	< .001
	Attention lapses	-0.02	0.34	-0.05	.961
	Session * Attention lapses	0.01	0.01	0.64	.520
Spontaneous Mind-Wandering Scale (N = 176)	Intercept	2.16	0.46	4.67	< .001
	Video order (New Yorker First)	-0.58	0.66	-0.88	.381
	Session (Second Session)	0.40	0.01	45.52	< .001
	Spontaneous mind-wandering	0.30	0.33	0.90	.366
	Session * Spontaneous mind-wandering	0.00	0.01	0.04	.966
Deliberate Mind-Wandering Scale (N = 176)	Intercept	2.09	0.46	4.56	< .001
	Video order (New Yorker First)	-0.43	0.65	-0.65	.514
	Session (Second Session)	0.39	0.01	44.77	< .001
	Deliberate mind-wandering	0.38	0.33	1.15	.249
	Session * Deliberate mind-wandering	0.08	0.01	9.36	< .001

Note. Coefficients for the effect of video order are shown for the New Yorker First condition (Brain Magic First is the reference condition) and coefficients for the effect of session are shown for the second session (the first session is the reference condition). Scores on the individual difference measures are standardized. *P*-values are based on Wald *z*-tests comparing estimates against zero.

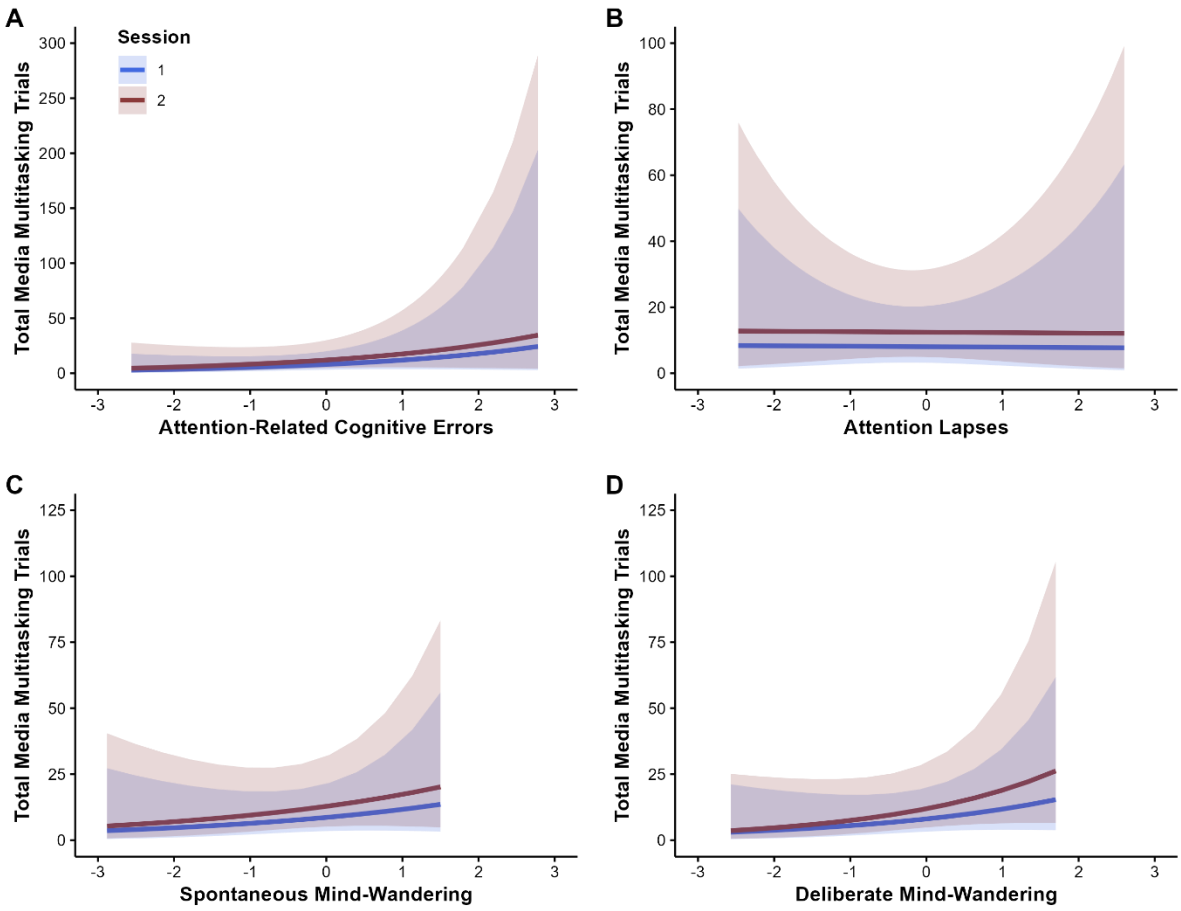


Figure 5.3. Predicted relations between total trials spent media multitasking and (A) attention-related cognitive errors, (B) attention lapses, (C) spontaneous mind-wandering, and (D) deliberate mind-wandering based on results of the GLMMs, which control for video order. The shaded regions represent 95% confidence intervals.

5.3.4.2 Self-Regulatory Traits

Results of the GLMMs involving the self-regulatory traits are shown in Table 5.4 as well as Figure 5.4. In the model involving conscientiousness, there was a significant interaction with session, such that conscientiousness was more strongly positively associated with media multitasking during the second session than the first. The model involving self-control also revealed an interaction with session. Here, self-control was more strongly negatively related to

media multitasking in the second session compared to the first. There was also an interaction with session in the model involving boredom proneness. Specifically, higher levels of boredom proneness were associated with less media multitasking, with this relation being stronger during the first session relative to the second session.

Table 5.4.

GLMM Results for Media Multitasking as a Function of Session and the Self-Regulatory Traits, Controlling for Video Order

Predictor of Interest	Fixed Effects	Estimate	SE	z	p
Conscientiousness	Intercept	2.01	0.47	4.26	< .001
(*N* = 164)	Video order (New Yorker First)	-0.18	0.68	-0.27	.786
	Session (Second Session)	0.43	0.01	47.47	< .001
	Conscientiousness	0.06	0.34	0.18	.858
	Session * Conscientiousness	0.05	0.01	6.00	< .001
Self-Control	Intercept	2.24	0.45	4.95	< .001
(*N* = 169)	Video order (New Yorker First)	-0.60	0.66	-0.91	.361
	Session (Second Session)	0.43	0.01	48.17	< .001
	Self-control	-0.46	0.33	-1.41	.159
	Session * Self-control	-0.13	0.01	-14.71	< .001
Boredom Proneness	Intercept	2.10	0.47	4.46	< .001
(*N* = 170)	Video order (New Yorker First)	-0.50	0.67	-0.76	.451
	Session (Second Session)	0.44	0.01	49.41	< .001
	Boredom proneness	-0.48	0.33	-1.44	.149
	Session * Boredom proneness	0.18	0.01	19.19	< .001

Note. Coefficients for the effect of video order are shown for the New Yorker First condition (the Brain Magic First condition is the reference condition) and coefficients for the effect of session are shown for the second session (the first session is the reference condition). Scores on the individual difference measures are standardized. *P*-values are based on Wald *z*-tests comparing estimates against zero.

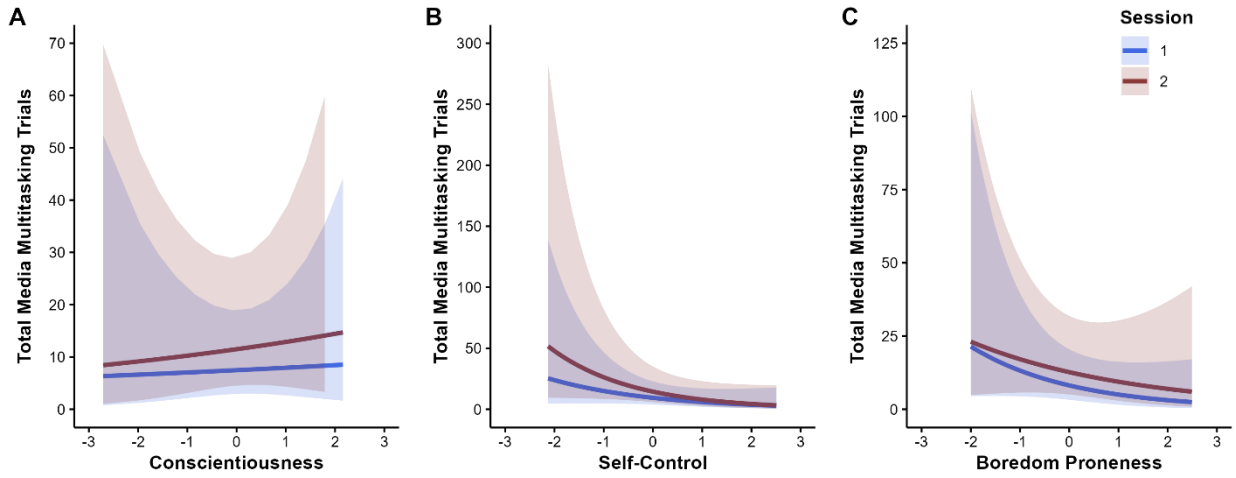


Figure 5.4. Predicted relations between total trials spent media multitasking and (A) conscientiousness, (B) self-control, and (C) boredom proneness based on results of the GLMMs, which control for video order. The shaded regions represent 95% confidence intervals.

5.3.4.3 Media Multitasking Questionnaires

Results of the GLMMs involving the Media Multitasking Index and the Short Media Multitasking Measure are shown in Table 5.5 and Figure 5.5. Results pertaining to the Media Multitasking Index should be interpreted with caution, as only 70 participants provided complete responses on this measure. There was a main effect of scores on the Media Multitasking Index, as well as an interaction between scores on this measure and study session. Scores on the Media Multitasking Index were more strongly associated with greater media multitasking during the first session compared to the second session. The model involving the Short Media Multitasking Measure also revealed an interaction with session. Interestingly, higher scores on the Short Media Multitasking Measure were related to greater media multitasking during the first session, but less media multitasking during the second session.

Table 5.5.

GLMM Results for In-Study Media Multitasking as a Function of Session and Media Multitasking Tendencies in Daily Life, Controlling for Video Order

Predictor of Interest	Fixed Effects	Estimate	SE	z	p
Media Multitasking Index (N = 70)	Intercept	2.50	0.59	4.20	< .001
	Video order (New Yorker First)	-0.14	0.95	-0.15	.881
	Session (Second Session)	0.50	0.01	36.69	< .001
	Media Multitasking Index	1.09	0.47	2.35	.019
	Session * Media Multitasking Index	-0.31	0.01	-22.24	< .001
Short Media Multitasking Measure (N = 169)	Intercept	2.05	0.47	4.36	< .001
	Video order (New Yorker First)	-0.35	0.67	-0.52	.606
	Session (Second Session)	0.39	0.01	43.55	< .001
	Short Media Multitasking Measure	0.08	0.34	0.24	.814
	Session * Short Media Multitasking Measure	-0.15	0.01	-16.30	< .001

Note. Coefficients for the effect of video order are shown for the New Yorker First condition (the Brain Magic First condition is the reference condition) and coefficients for the effect of session are shown for the second session (the first session is the reference condition). Scores on the media multitasking questionnaires are standardized. *P*-values are based on Wald *z*-tests comparing estimates against zero.

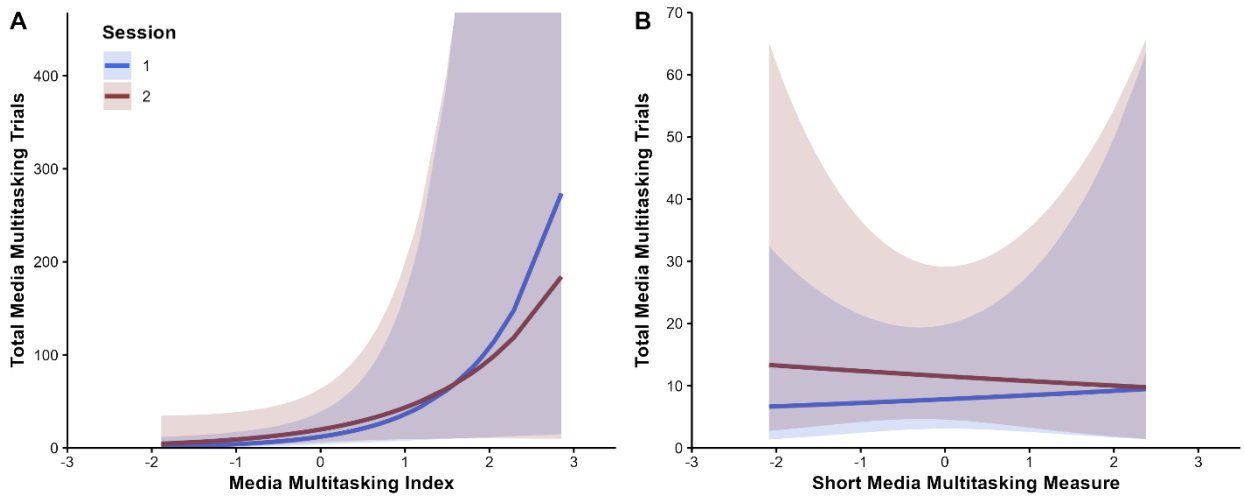


Figure 5.5. Predicted relations between total trials spent media multitasking and scores on the (A) Media Multitasking Index and (B) Short Media Multitasking Measure based on results of the GLMMs, which control for video order. The shaded regions represent 95% confidence intervals. Confidence intervals for the Media Multitasking Index exceed the possible range of media multitasking trials in this study and are therefore cut off at more extreme scores on the Media Multitasking Index

5.4 Discussion

Findings from the present study provide support for the notion that when key contextual variables, such as physical setting, available tasks, and opportunities to media multitask, are held constant, individuals show relatively consistent media multitasking behaviours across multiple testing sessions. Although media multitasking was correlated across sessions, rates significantly increased from the first to the second session in both video order conditions. This difference may be attributable to participants' increased familiarity with the 1-back task and the video toggle option during the second session. That is, by the second session, participants may have realized that they could media multitask with little impact on performance and/or that media multitasking could help reduce the perceived monotony of the task. While these possibilities were not explicitly tested, this latter explanation would be consistent with the

numerically (non-significant) increase in task enjoyment from the first to the second session. Interestingly, changes in media multitasking across sessions also varied as a function of video order. While it is possible that this interaction was due to sampling differences across the two video order conditions, it is also possible that the video participants saw during the first session meaningfully impacted their likelihood of media multitasking during the second session. The nature of this impact is unclear however, as changes in media multitasking across sessions did not appear to be tied to changes in participants' enjoyment of the videos, at least in the group that viewed the Brain Magic video first. While participants in this group showed the steepest increase in media multitasking across sessions, their enjoyment of the videos decreased across sessions.

Concerning whether individual differences predict media multitasking when context is held constant, none were found to predict media multitasking alone; however, several individual difference factors interacted with session when predicting media multitasking. In nearly all cases, the directions of the relations remained consistent across sessions, although the strength of the relations varied, likely due to contextual differences across sessions that were not explicitly measured or accounted for. Future research could examine the stability of the interactions between the individual difference factors and sessions to provide insight into the extent to which they reflect changes due to repeated exposure to the paradigm (e.g., increased familiarity across sessions) or circumstantial differences specific to the sample examined in the present study.

Given that the stability of these interactions is currently uncertain, they are not interpreted in detail below; however, certain general trends are discussed in brief. Regarding individual differences in attention, attention lapses and spontaneous mind-wandering were

unrelated to in-study media multitasking; however, greater attention-related cognitive errors and deliberate mind-wandering were associated with higher rates of media multitasking. It is possible that these two attention-related measures were more predictive of media multitasking due to the specific forms of disengagement they assess. Many items on the Attention-Related Cognitive Errors Scale refer to physical errors (e.g., retrieving the wrong object from the fridge) resulting from inattention, while items on the Deliberate Mind-Wandering Scale focus on intentional shifts in attention. These more overt or intentional forms of disengagement may be more relevant to one's decisions to engage in off-task behaviours like media multitasking. In contrast, the Lapses Only variant of the Mindful Attention Awareness Scale and the Spontaneous Mind-Wandering Scale assess more passive or unintentional forms of disengagement which may be less relevant to decisions to media multitask.

Each of the self-regulatory traits also interacted with session, although relations involving these traits did not always emerge in the hypothesized directions. As anticipated, self-control was associated with lower overall rates of media multitasking, but unexpectedly, higher conscientiousness was related to *greater* levels of media multitasking, and higher boredom proneness was associated with *lower* levels of media multitasking. Although additional research is needed to understand the mechanisms underlying these relations, they may reflect differences in how individuals high in these traits perceive the value and/or appropriateness of media multitasking in this specific paradigm, such as whether they view it as a behaviour to be avoided or one that is likely to alleviate feelings of boredom.

The media multitasking questionnaires additionally interacted with session when predicting media multitasking. As anticipated, higher scores on the Media Multitasking Index

were associated with greater media multitasking during both sessions. In contrast, higher scores on the Short Media Multitasking Measure predicted *greater* media multitasking in the first session, but *less* media multitasking in the second session. The differing patterns across the two measures are surprising given that both measures are intended to evaluate tendencies to combine multiple forms of media in daily life and would therefore be expected to relate similarly to in-lab media multitasking.

One possible explanation relates to the range of multitasking behaviours captured by each measure. The Short Media Multitasking Measure focuses on how often individuals combine just four types of media, whereas the Media Multitasking Index assesses tendencies to combine twelve media types. In capturing a broader range of media multitasking behaviours, the Media Multitasking Index may better reflect general multitasking preferences, making it a more reliable predictor of in-lab media multitasking. In contrast, the Short Media Multitasking Measure may reflect more specific media multitasking habits that share little overlap with in-lab media multitasking, leading to inconsistent relations over time.

In sum, this study provided further evidence for an interplay between individual difference and contextual factors in predicting media multitasking. When key contextual variables (e.g., task type, environment) were held constant, individuals' media multitasking behaviours remained relatively consistent over time. Moreover, these behaviours appeared to be at least partially driven by individual differences in traits related to attention and self-regulation, as well as tendencies to media multitask in daily life. Despite several contextual factors being fixed, rates of media multitasking and the relations between individual difference factors and media multitasking varied across sessions. This suggests that several contextual variables that

were not explicitly assessed or controlled influenced individuals' media multitasking patterns and further highlights the major role context plays in this behaviour.

Chapter 6: General Discussion

6.1 General Summary of Findings

The purpose of the present investigations was to provide a more nuanced understanding of the drivers of media multitasking by addressing two major gaps in the literature. Chapters 2 and 3 explored the understudied temporal dynamics of media multitasking. These chapters approached the behaviour from an opportunity costs perspective to understand how moment-to-moment changes in certain variables impact how media multitasking evolves over the course of a primary task. While most existing research has taken one of two approaches to studying media multitasking – either examining relations between individual difference factors and questionnaire measures of media multitasking or studying context-dependent variables with more immediate impacts on media multitasking – Chapters 4 and 5 considered the joint role of both classes of variables in predicting media multitasking.

Chapter 2 provided evidence that rising opportunity costs, signaled by increases in state boredom, drive increases in media multitasking over time. This finding is consistent with previous research suggesting that conditions associated with higher opportunity costs lead to heightened levels of boredom (Struk et al., 2020; Tam & Inzlicht, 2024), and that individuals engage in task-switching in an attempt to alleviate feelings of boredom (although this behaviour may in fact exacerbate feelings of boredom; Tam & Inzlicht, 2024). Chapter 3 demonstrated that increasing motivation to complete a primary task, which should reduce the perceived opportunity costs of engaging in the task, effectively attenuates temporal increases in media multitasking. In addition to highlighting boredom and motivation as key variables that shape how media multitasking evolves over time, this work challenges a major class of theories in the sustained attention literature. That is, in showing that individuals become *more* rather than less

likely to take on additional tasks over time, findings from Chapters 2 and 3 suggest that the attention and performance decrements commonly observed in the sustained attention literature (e.g., Brosowsky et al., 2023; Krimsky et al., 2017; Risko et al., 2012; Thomson et al., 2014; Yanko & Spalek, 2014) may not be solely attributable to a gradual depletion of cognitive resources. Instead, the findings align more closely theories centered on varying cost-benefit analyses, like the opportunity costs account (Kurzban et al., 2013).

Chapter 4 showed that individual differences in traits related to attention and self-regulation, as well as scores on questionnaire measures of media multitasking, predict in-study media multitasking, but do so by interacting with context-dependent variables. Indeed, these relations varied considerably across levels of task difficulty and task order, and in ways that did not consistently lend themselves to simple interpretations. It is possible that the observed pattern of results was partly due to participants engaging in media multitasking with content outside the experimental context. In line with this notion, individuals high in traits related to inattention (i.e., attention lapses and spontaneous mind-wandering) and low self-regulation (i.e., boredom proneness), as well as those who reported frequently media multitasking in daily life, were more likely to report having engaged in extra-experimental media multitasking. These were some of the traits that were associated with in-study media multitasking in directions opposite to those hypothesized. Building upon on the work presented in Chapter 4, Chapter 5 demonstrated that, when key contextual variables (e.g., physical setting, task, opportunities to media multitask) are held constant, individuals exhibit consistent media multitasking behaviours over time. The trends observed in this chapter further suggest that, under these circumstances, media multitasking may be partially driven by individual differences in traits related to inattention and

low self-regulation. They also provided support for the notion that self-reported media multitasking in daily life is associated with in-lab media multitasking, although the direction of this association varied across sessions for one of the media multitasking questionnaires (i.e., the Short Media Multitasking Measure).

Together, findings from Chapters 4 and 5 provide evidence that media multitasking arises from an interplay between stable individual difference factors and more variable context-dependent factors. Findings from this study also help address an additional underexplored question concerning whether questionnaire measures of media multitasking predict in-the-moment instances of this behaviour (e.g., in the laboratory). While several prior studies have failed to find such a relation in their media multitasking paradigms (Lopez & Orr, 2022; Lui et al., 2023; Shih, 2013, although see Rigby et al., 2017), Chapters 4 and 5 demonstrated that two widely used media multitasking questionnaires (Baumgartner et al., 2017; Ophir et al., 2009) interacted with contextual factors (e.g., task difficulty, study session) when predicting in-lab media multitasking. Although further research is needed to provide insight into the stability of these findings, this may indicate an overlap between the mechanisms that drive media multitasking in Ralph and colleagues' (2020) paradigm and those driving media multitasking in the real world, which would support the ecological validity of this paradigm.

6.2 A Holistic Approach to Considering Media Multitasking[5]

The importance of understanding the interplay between stable individual difference factors and moment-to-moment changes in contextual factors underscores the need for a comprehensive model of the drivers of media multitasking. The model proposed in this section (depicted in Figure 6.1) categorizes the drivers of media multitasking into five components. Factors within these components exist on a spectrum ranging from *stable*, reflecting unchanging and fixed capabilities and characteristics, to *transient*, reflecting variable and shifting considerations and contexts. The joint influence of the five components is theorized to determine one's likelihood of media multitasking at any given moment. This section briefly outlines each of the five components and discusses how the proposed model could advance current knowledge on the drivers of media multitasking.

6.2.1 The Five Interactive Components That Drive Media Multitasking

6.2.1.1 Cognitive Architectural Component. The first component reflects primarily stable neural and cognitive features that may determine one's ability to sustain one's attention on a single task or allocate one's attention in ways that promote successful multitasking. These features include the attention-related variables explored in the previous chapters (e.g., attention-related cognitive errors), which appeared to play a role in participants' in-study media multitasking. Further support for the role of a cognitive architectural component can be seen through prior work demonstrating that media multitasking is higher among individuals with poor cognitive control (Matthews et al., 2022; Ophir et al., 2009) or tendencies reflective of poor

[5] A version of the model presented in this chapter is available at: Drody, A. C., Pereira, E. J., & Smilek, D. (2025). Attention in our digital ecosystem: The five interactive components that drive media multitasking. *Psychonomic Bulletin & Review*, 1-18.

cognitive control, such as higher distractibility (Moisala et al., 2016), poorer decision-making (Müller et al., 2021), and greater executive difficulties (Magen, 2017; Rogobete et al., 2020).

6.2.1.2 Dispositional Component. The second component reflects relatively stable features within individuals that speak to personality characteristics and trait-level differences that make one more or less prone to media multitasking. The self-regulatory traits examined in Chapters 4 and 5 (conscientiousness, self-control, and boredom proneness) likely operate within this component. Further evidence for this component comes from work linking decreased self-esteem, greater depression and increased social anxiety to more frequent media multitasking (Becker et al., 2013). High scores on measures of impulsivity (Magen, 2017; Minear et al., 2013; Sanbonmatsu et al., 2013; Schutten et al., 2017) and sensation-seeking (Chang, 2017; Duff et al., 2014; Kononova, 2013; Lim & Shim, 2016; Sanbonmatsu et al., 2013) have also been associated with greater media multitasking.

6.2.1.3 Metacognitive Component. The third component reflects features that are both stable and transient related to an individuals' awareness of their ability to effectively media multitask. This can include their confidence in their multitasking abilities and their (believed) capacity to detect errors. Metacognitive beliefs are typically considered to be stable (Cartwright-Hatton & Wells, 1997; Faissner et al., 2018; Nordahl et al., 2023), such that they are gradually formed over time as individuals gain more experience with a particular behaviour (Bandura, 1977; Rouault & Fleming, 2020); however, there may be a strong transient aspect of this component, as the presence of new information has been shown to quickly alter individuals' beliefs (Gilbert et al., 2019; Grinschgl et al., 2021; O'Leary & Fletcher, 2024). Supporting this

component, prior work has shown that individuals are aware of the performance costs associated with media multitasking (Froese et al., 2010; Gingerich & Lineweaver, 2014) and may modulate their media multitasking behaviours to minimize these performance costs (Baumgartner & Wiradhany, 2022; Ralph et al., 2020; Wang et al., 2015).

6.2.1.4 Task Valuative Component. The fourth component reflects features that impact the value one places on the activities they are currently engaged in relative to the costs and benefits they attribute to media multitasking. Media multitasking should be more likely when engaging in the behaviour is more highly valued than fully attending to one's primary task. There are cases in which task valuation may present as a more stable judgment. For instance, individuals associate several global costs (e.g., poorer task performance, reduced efficiency, negative emotions, feelings of disengagement; Bardhi et al., 2010; Calderwood et al., 2016; Ralph et al., 2020) and benefits (increased efficiency, social connection, reduced negative affect; Bardhi et al., 2010, Calderwood et al., 2016) with media multitasking. However, findings from Chapters 2 and 3, which showed that variables tied to perceived opportunity costs (i.e., boredom, effort, motivation) change over time and co-vary with media multitasking, highlight a strong transient aspect of this component.

6.2.1.5 Environmental Component. The fifth component is predominantly transient and emphasizes the role of one's current environment in media multitasking. This can include the features of the tasks in one's environment. Indeed, certain tasks appear to promote greater media multitasking than others, such as those that do not overlap in sensory modality with the primary task (e.g., having separate audio, visual, or motor contributions), those that provide

individuals with a high degree of control over the rate at which information is presented (Baumgartner & Wiradhany, 2022; Wang et al., 2015), and those that place low cognitive demands on the individual (Ralph et al., 2020; Wang et al., 2015). Social norms and expectations surrounding media multitasking in a given environment may also be relevant variables within this component. In line with this notion, prior work suggests that media multitasking is more common in settings in which it is perceived as more socially acceptable. For example, individuals have been shown to media multitask less when watching television with others versus alone (Voorveld & Viswanathan, 2015). Moreover, students frequently cite the commonality of media multitasking in lecture settings to justify their own in-class media multitasking (Parry & le Roux, 2017).

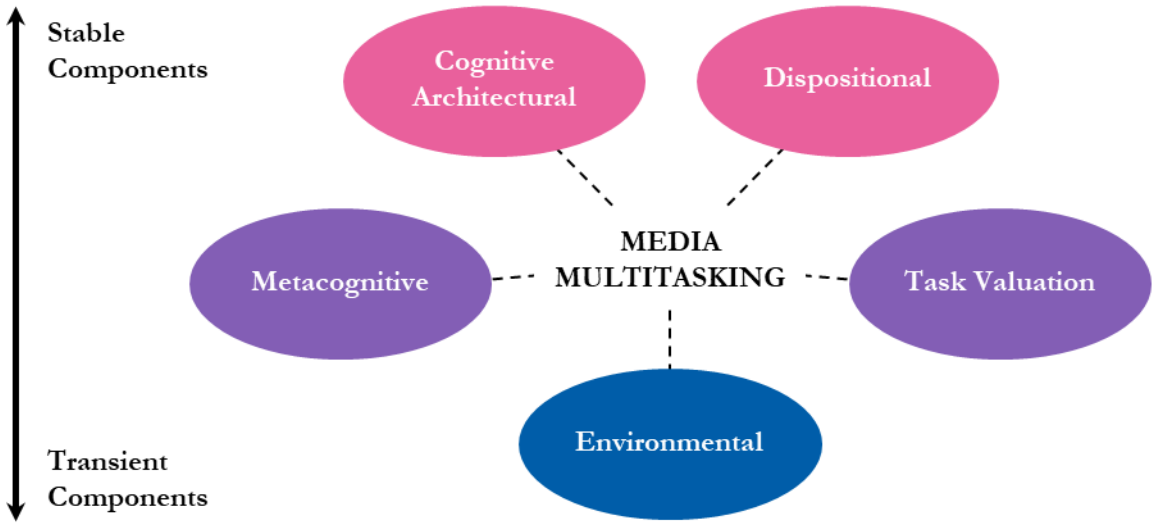


Figure 6.1. Depiction of the five components within the interactive model of media multitasking, which exist on a core temporal dimension that ranges from stable and intrinsic (above, pink) to transient and mutable (below, blue).

6.2.2 Understanding the Complexity of Media Multitasking

This model assumes that each of the five components interact to give rise to one's likelihood of media multitasking at any given moment. Findings from Chapter 4 provide evidence for this view by showing that traits within the cognitive architectural (e.g., attention-related traits) and dispositional components (e.g., self-regulatory traits) predicted media multitasking differently depending on environmental factors like task difficulty. By allowing for an interplay between these components, the proposed model can account for a wide range of media multitasking findings. Such instances are depicted in Figure 6.2, which illustrates hypothetical media multitasking scenarios, with ovals representing each component and the size and opacity of each oval representing the extent to which the component encourages media multitasking. For example, if considering between-group effects, media multitasking may be higher for individuals who have a greater disposition towards this behaviour (e.g., high vs. low boredom proneness); but as seen in Figure 6.2A, this difference may not hold if environmental opportunities to media multitask are not abundant (e.g., at work vs. at home). Additionally, if considering within-person effects, an individual put in the same environment on different days (e.g., a student attending a lecture) should have the same cognitive architectural, dispositional, and environmental constraints, and therefore be expected to media multitask at the same overall rate on both days; however as seen in Figure 6.2B, media multitasking may differ across days because their motivation to perform well differs between days (thereby changing their task valuation).

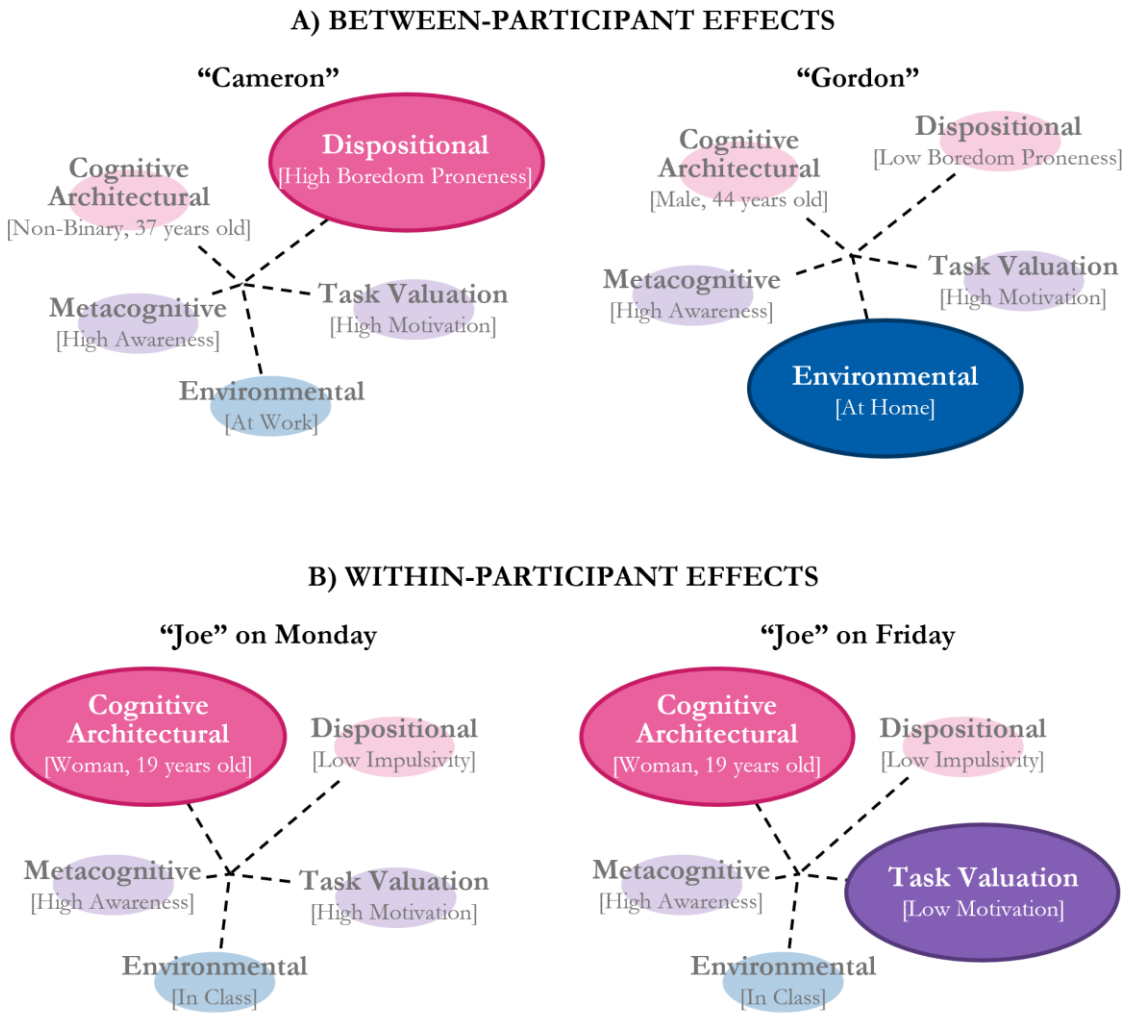


Figure 6.2. Graphical depiction of a hypothetical scenario in which (A) two individuals with different levels of boredom proneness show a similar likelihood of media multitasking due to differences within the environmental component, and (B) the same individual has a different likelihood of media multitasking over consecutive days due to variability within the task valuation component. In both figures, the size and opacity of the ovals represent the degree to which each component is expected to impact one's decision to media multitask.

Importantly, this model implies that a comprehensive understanding of media multitasking requires consideration of all five components within the model. Prior work studying either the stable (i.e., individual difference) or transient (e.g., context-dependent) components have contributed substantially to the current understanding of media multitasking; however, this

primary focus on single components has likely led to the large variance in findings across media multitasking studies (Kong et al., 2023; Wiradhany & Koerts, 2021; Wiradhany & Nieuwenstein, 2017). Although further work is required to test the validity of this model, it has the potential to improve researchers' predictive power when exploring media multitasking and provide them with deeper insight into the mechanisms driving this behaviour.

The work presented in this thesis highlights numerous state-like (e.g., boredom, motivation) and context-dependent (e.g., task difficulty) factors that may shape patterns of media multitasking from one moment to the next. The studies presented here also demonstrate that these variables interact in complex ways with individual characteristics (e.g., individual differences in attention, self-regulatory traits, and tendencies to media multitask in daily life) when predicting in-the-moment instances of media multitasking. While more research is needed to better understand the nature of these interactions, it is clear that media multitasking is a highly variable behaviour that changes in response to multiple layers of influence. The model proposed in this chapter may provide a useful framework for considering and guiding exploration on these interactions.

References

Al-Saggaf, Y., & MacCulloch, R. (2018). Phubbing: How frequent? Who is phubbed? In which situation? And using which apps? In *39th International Conference on Information Systems (ICIS 2018): Bridging the internet of people, data, and things* (International Conference on Information Systems 2018, ICIS 2018). Association for Information Systems.

Aygar, H., Arslantas, D., Oktar, D., Dağtekin, G., Tozun, M., Unsal, A., & Dagtekin, G. (2021). Determination of the prevalence of phubbing and its possible relations with personality characteristics and with the other factors among the students of the faculty of medicine from western Turkey. *International Research Journal of Social Sciences, 10*(1), 20-27.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215.

Barbed-Castrejón, N., Navaridas-Nalda, F., Mason, O., & Ortuño-Sierra, J. (2024). Prevalence of phubbing behaviour in school and university students in Spain. *Frontiers in Psychology*, *15*. https://doi.org/10.3389/fpsyg.2024.1396863

Bardhi, F., Rohm, A. J., & Sultan, F. (2010). Tuning in and tuning out: media multitasking among young consumers. *Journal of Consumer Behaviour*, *9*(4), 316-332. https://doi-org.proxy.lib.uwaterloo.ca/10.1002/cb.320

Baumgartner, S. E., Lemmens, J. S., Weeda, W. D., & Huizinga, M. (2017). Measuring media multitasking: Development of a short measure of media multitasking for adolescents. *Journal of Media Psychology*, *29*(2), 92–101. https://doi.org/10.1027/1864-1105/A000167

Baumgartner, S. E., Weeda, W. D., van der Heijden, L. L., & Huizinga, M. (2014). The relationship between media multitasking and executive function in early adolescents. *Journal of Early Adolescence*, *34*(8), 1120–1144. https://doi.org/10.1177/0272431614523133/FORMAT/EPUB

Baumgartner, S. E., & Wiradhany, W. (2022). Not all media multitasking is the same: The frequency of media multitasking depends on cognitive and affective characteristics of media combinations. *Psychology of Popular Media*, *11*(1), 1–12. https://doi.org/10.1037/ppm0000338

Becker, M. W., Alzahabi, R., & Hopwood, C. J. (2013). Media multitasking is associated with symptoms of depression and social anxiety. *Cyberpsychology, Behavior, and Social Networking*, *16*(2), 132–135. https://doi.org/10.1089/cyber.2012.0291

Bellur, S., Nowak, K. L., & Hull, K. S. (2015). Make it our time: In class multitaskers have lower academic performance. *Computers in Human Behavior*, *53*, 63–70. https://doi.org/10.1016/j.chb.2015.06.027

Beuckels, E., Ye, G., Hudders, L., & Cauberghe, V. (2021). Media multitasking: A bibliometric approach and literature review. *Frontiers in Psychology*, *12*, 623643. https://doi.org/10.3389/FPSYG.2021.623643/BIBTEX

Błachnio, A., Przepiorka, A., Cudo, A., Angeluci, A., Ben-Ezra, M., Durak, M., Kaniasty, K., Mazzoni, E., Senol-Durak, E., Hou, W. K., & Benvenuti, M. (2023). Self-control and digital media addiction: The mediating role of media multitasking and time style. *Psychology Research and Behavior Management, 16*, 2283–2296. https://doi.org/10.2147/PRBM.S408993

Bowman, L. L., Levine, L. E., Waite, B. M., & Gendron, M. (2010). Can students really multitask? An experimental study of instant messaging while reading. *Computers and Education*, *54*(4), 927–931. https://doi.org/10.1016/j.compedu.2009.09.024

Brasel, S. A., & Gips, J. (2017). Media multitasking: How visual cues affect switching behavior. *Computers in Human Behavior*, *77*, 258–265. https://doi.org/10.1016/J.CHB.2017.08.042

Brosowsky, N. P., DeGutis, J., Esterman, M., Smilek, D., & Seli, P. (2023). Mind wandering, motivation, and task performance over time: Evidence that motivation insulates people from the negative effects of mind wandering. *Psychology of Consciousness: Theory Research, and Practice*, *10*(4), 475–486. https://doi.org/10.1037/cns0000263

Cain, M. S., & Mitroff, S. R. (2011). Distractor filtering in media multitaskers. *Perception*, *40*(10), 1183–1192. https://doi.org/10.1068/p7017

Calderwood, C., Ackerman, P. L., & Conklin, E. M. (2014). What else do college students "do" while studying? An investigation of multitasking. *Computers & Education*, *75*, 19–29. https://doi.org/10.1016/J.COMPEDU.2014.02.004

Calderwood, C., Green, J. D., Joy-Gaba, J. A., & Moloney, J. M. (2016). Forecasting errors in student media multitasking during homework completion. *Computers & Education*, *94*, 37–48. https://doi.org/10.1016/J.COMPEDU.2015.10.021

Cao, X., & Yu, L. (2019). Exploring the influence of excessive social media use at work: A three-dimension usage perspective. *International Journal of Information Management*, *46*, 83–92. https://doi.org/10.1016/j.ijinfomgt.2018.11.019

Carriere, J. S. A., Cheyne, J. A., & Smilek, D. (2008). Everyday attention lapses and memory failures: The affective consequences of mindlessness. *Consciousness and Cognition*, *17*(3), 835–847. https://doi.org/10.1016/J.CONCOG.2007.04.008

Carriere, J. S. A., Seli, P., & Smilek, D. (2013). Wandering in both mind and body: Individual differences in mind wandering and inattention predict fidgeting. *Canadian Journal of Experimental Psychology*, *67*(1), 19–31. https://doi.org/10.1037/A0031438

Cartwright-Hatton, S., & Wells, A. (1997). Beliefs about worry and intrusions: The meta-cognitions questionnaire and its correlates. *Journal of Anxiety Disorders*, *11*(3), 279–296. https://doi.org/10.1016/S0887-6185(97)00011-X

Chang, Y. (2017). Why do young people multitask with multiple media? Explicating the relationships among sensation seeking, needs, and media multitasking behavior. *Media Psychology*, *20*(4), 685–703. https://doi.org/10.1080/15213269.2016.1247717

Charoensukmongkol, P. (2014). Effects of support and job demands on social media use and work outcomes. *Computers in Human Behavior*, *36*, 340–349. https://doi.org/10.1016/j.chb.2014.03.061

Cheyne, J. A., Carriere, J. S. A., & Smilek, D. (2006). Absent-mindedness: Lapses of conscious awareness and everyday cognitive failures. *Consciousness and Cognition*, *15*(3), 578–592. https://doi.org/10.1016/J.CONCOG.2005.11.009

Chinchanachokchai, S., Duff, B. R. L., & Sar, S. (2015). The effect of multitasking on time perception, enjoyment, and ad evaluation. *Computers in Human Behavior*, *45*, 185–191. https://doi.org/10.1016/j.chb.2014.11.087

Dahlen, E. R., Martin, R. C., Ragan, K., & Kuhlman, M. M. (2004). Boredom proneness in anger and aggression: effects of impulsiveness and sensation seeking. *Personality and Individual Differences*, *37*(8), 1615–1627. https://doi.org/10.1016/J.PAID.2004.02.016

Dahlen, E. R., Martin, R. C., Ragan, K., & Kuhlman, M. M. (2005). Driving anger, sensation seeking, impulsiveness, and boredom proneness in the prediction of unsafe driving. *Accident Analysis & Prevention*, *37*(2), 341–348. https://doi.org/10.1016/J.AAP.2004.10.006

Danckert, J. (2019). Boredom: Managing the delicate balance between exploration and exploitation. In *Boredom Is in Your Mind: A Shared Psychological-Philosophical Approach* (37–53). Spinger, Cham. https://doi.org/10.1007/978-3-030-26395-9_3

Davies, D. R., & Parasuraman, R. (1982). *The psychology of vigilance*. Academic Press.

Demirbilek, M., & Talan, T. (2018). The effect of social media multitasking on classroom performance. *Active Learning in Higher Education*, *19*(2), 117–129. https://doi.org/10.1177/1469787417721382

Deng, L., Zhou, Y., & Broadbent, J. (2024). Distraction, multitasking and self-regulation inside university classroom. *Education and Information Technologies, 29,* 23957–23979. https://doi.org/10.1007/s10639-024-12786-w

Drody, A. C., Pereira, E. J., & Smilek, D. (2023). A desire for distraction: uncovering the rates of media multitasking during online research studies. *Scientific Reports*, *13*(1). https://doi.org/10.1038/s41598-023-27606-3

Drody, A. C., Ralph, B. C. W., Danckert, J., & Smilek, D. (2022). Boredom and media multitasking. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.807667

Duff, B. R.-L., Yoon, G., Wang, Z. (Glenn), & Anghelcev, G. (2014). Doing it all: An exploratory study of predictors of media multitasking. *Journal of Interactive Advertising*, *14*(1), 11–23. https://doi.org/10.1080/15252019.2014.884480

Faissner, M., Kriston, L., Moritz, S., & Jelinek, L. (2018). Course and stability of cognitive and metacognitive beliefs in depression. *Depression and Anxiety*, *35*(12), 1239–1246. https://doi.org/10.1002/DA.22834

Fisher, J. T., Hopp, F. R., Chen, Y., & Weber, R. (2023). Uncovering the structure of media multitasking and attention problems using network analytic techniques. *Computers in Human Behavior*, *147*. https://doi.org/10.1016/j.chb.2023.107829

Fox, A. B., Rosen, J., & Crawford, M. (2009). Distractions, distractions: Does instant messaging affect college students' performance on a concurrent reading comprehension task? *Cyberpsychology and Behavior*, *12*(1), 51–53. https://doi.org/10.1089/cpb.2008.0107

Froese, A. D., Carpenter, C. N., Inman, D. A., Schooley, J. R., Barnes, R. B., Brecht, P. W., & Chacon, J. D. (2010). Effects of classroom cell phone use on expected and actual learning. *College Student Journal*, *46*, 323–332.

Gilbert, S. J., Bird, A., Carpenter, J. M., Fleming, S. M., Sachdeva, C., & Tsai, P. C. (2019). Optimal use of reminders: Metacognition, effort, and cognitive offloading. *Journal of Experimental Psychology: General*, *149*(3), 501–517. https://doi.org/10.1037/XGE0000652

Gillies, J. C. P., & Dozois, D. J. A. (2021). How long do mood induction procedure (MIP) primes really last? Implications for cognitive vulnerability research. *Journal of Affective Disorders*, *292*, 328–336. https://doi.org/10.1016/j.jad.2021.05.047

Gingerich, A. C., & Lineweaver, T. T. (2014). Omg! Texting in class = u fail :(Empirical evidence that text messaging during class disrupts comprehension. *Teaching of Psychology, 41*(1), 44–51. https://doi-org.proxy.lib.uwaterloo.ca/10.1177/0098628313514177

Goltz, F., & Sadakata, M. (2021). Do you listen to music while studying? A portrait of how people use music to optimize their cognitive performance. *Acta Psychologica*, *220*, 103417. https://doi.org/10.1016/J.ACTPSY.2021.103417

Greenlee, E. T., DeLucia, P. R., & Lui, T. G. (2024). Modality changes in vigilance displays: Further evidence of supramodal resource depletion in vigilance. *Human Factors*, *66*(2), 424–436. https://doi.org/10.1177/00187208221099793

Grier, R. A., Warm, J. S., Dember, W. N., Matthews, G., Galinsky, T. L., Szalma, J. L., & Parasuraman, R. (2003). The vigilance decrement reflects limitations in effortful attention, not mindlessness. *Human Factors*, *45*(3), 349-359. https://doi.org/10.1518/hfes.45.3.349.27253

Grinschgl S, Meyerhoff HS, Schwan S, Papenmeier F. (2021). From metacognitive beliefs to strategy selection: Does fake performance feedback influence cognitive offloading? *Psychological Research*, *85*(7), 2654–2666. https://doi.org/10.1007/s00426-020-01435-9

Hayashi, Y., & Nenstiel, J. N. (2021). Media multitasking in the classroom: Problematic mobile phone use and impulse control as predictors of texting in the classroom. *Current Psychology*, *40*(9), 4500–4506. https://doi.org/10.1007/S12144-019-00395-7/TABLES/2

Helton, W. S., Hollander, T. D., Warm, J. S., Matthews, G., Dember, W. N., Wallaart, M., Beauchamp, G., Parasuraman, R., & Hancock, P. A. (2005). Signal regularity and the

mindlessness model of vigilance. *British Journal of Psychology*, *96*(2), 249–261. https://doi.org/10.1348/000712605X38369

Helton, W. S., & Russell, P. N. (2011). Working memory load and the vigilance decrement. *Experimental Brain Research*, *212*(3), 429–437. https://doi.org/10.1007/s00221-011-2749-1

Hembrooke, H., & Gay, G. (2003). The laptop and the lecture: The effects of multitasking in learning environments. *Journal of Computing in Higher Education 2003 15:1*, *15*(1), 46–64. https://doi.org/10.1007/BF02940852

Hunter, A., & Eastwood, J. D. (2018). Does state boredom cause failures of attention? Examining the relations between trait boredom, state boredom, and sustained attention. *Experimental Brain Research*, *236*(9), 2483–2492. https://doi.org/10.1007/s00221-016-4749-7

Isacescu, J., & Danckert, J. (2018). Exploring the relationship between boredom proneness and self-control in traumatic brain injury (TBI). *Experimental Brain Research*, *236*(9), 2493–2505. https://doi.org/10.1007/s00221-016-4674-9

Isacescu, J., Struk, A. A., & Danckert, J. (2017). Cognitive and affective predictors of boredom proneness. *Cognition and Emotion*, *31*(8), 1741–1748. https://doi.org/10.1080/02699931.2016.1259995

Jeong, S. H., & Fishbein, M. (2007). Predictors of multitasking with media: Media factors and audience factors. *Media Psychology*, *10*(3), 364–384. https://doi.org/10.1080/15213260701532948

Kass, S. J., & Vodanovich, S. J. (1990). Boredom proneness: Its relationship to Type A behavior pattern and sensation seeking. *Psychology: A Journal of Human Behavior*, *27*(3), 7–16.

Kirchner, W. K. (1958). Age differences in short-term retention of rapidly changing information. *Journal of Experimental Psychology*, *55*(4), 352–358.

Klauer, S. G., Guo, F., Simons-Morton, B. G., Ouimet, M. C., Lee, S. E., & Dingus, T. A. (2014). Distracted driving and risk of road crashes among novice and experienced drivers. *New England Journal of Medicine*, *370*(1), 54–59. https://doi.org/10.1056/NEJMSA1204142/SUPPL_FILE/NEJMSA1204142_DISCLOSURES.PDF

Klein, C. (2023). Understanding the relevance of digital media in higher education. *International Journal of Technology in Education and Science*, *7*(1), 71–82. https://doi.org/10.46328/ijtes.451

Kong, F., Meng, S., Deng, H., Wang, M., & Sun, X. (2023). Cognitive control in adolescents and young adults with media multitasking experience: A three-level meta-analysis. *Educational Psychology Review*, *35*(1). https://doi.org/10.1007/S10648-023-09746-0

Kononova, A. (2013). Multitasking Across Borders: A Cross-National Study of Media Multitasking Behaviors, Its Antecedents, and Outcomes. *International Journal of Communication*, *7*(0), 1688–1710. https://ijoc.org/index.php/ijoc/article/view/2119

Krimsky, M., Forster, D. E., Llabre, M. M., & Jha, A. P. (2017). The influence of time on task on mind wandering and visual working memory. *Cognition*, *169*, 84–90. https://doi.org/10.1016/j.cognition.2017.08.006

Kuijsters, A., Redi, J., de Ruyter, B., & Heynderickx, I. (2016). Inducing sadness and anxiousness through visual media: Measurement techniques and persistence. *Frontiers in Psychology*, *7,* 1141. https://doi.org/10.3389/fpsyg.2016.01141

Kurzban, R., Duckworth, A., Kable, J. W., & Myers, J. (2013). An opportunity cost model of subjective effort and task performance. *Behavioural and Brain Sciences*, *36*, 661–726. https://doi.org/10.1017/S0140525X12003196

Lang, A., & Chrzan, J. (2015). Media multitasking: Good, bad, or ugly? *Annals of the International Communication Association*, *39*(1), 99–128. https://doi.org/10.1080/23808985.2015.11679173

Lang, F. R., John, D., Lüdtke, O., Schupp, J., & Wagner, G. G. (2011). Short assessment of the Big Five: Robust across survey methods except telephone interviewing. *Behavior Research Methods*, *43*(2), 548. https://doi.org/10.3758/S13428-011-0066-Z

Lim, S., & Shim, H. (2016). Who multitasks on smartphones? Smartphone multitaskers' motivations and personality traits. *Cyberpsychology, Behavior, and Social Networking, 19*(3), 223–227. https://doi.org/10.1089/cyber.2015.0225

Loh, K. K., & Kanai, R. (2014). Higher media multi-tasking activity is associated with smaller gray-matter density in the anterior cingulate cortex. *PLoS ONE*, *9*(9). https://doi.org/10.1371/journal.pone.0106698

Lopez, J. J., & Orr, J. M. (2022). Effects of media multitasking frequency on a novel volitional multitasking paradigm. *PeerJ*, *10*, e12603. https://doi.org/10.7717/PEERJ.12603/SUPP-17

Lui, K. F. H., Fan, P., Yip, K. H. M., Wong, Y. K., & Wong, A. C. N. (2023). Are there associations between daily multitasking experience and multitasking performance? *Quarterly Journal of Experimental Psychology*, *76*(1), 133–146. https://doi.org/10.1177/17470218221087959

Luo, J., Cao, J., Yeung, P. S., Ng, J., & Sun, M. (2024). Mindfulness and growth mindset as protective factors for the impact of media multitasking on academic performance: The mediating role of

self-control. *Education and Information Technologies*, *29*(17), 22841–22858. https://doi.org/10.1007/S10639-024-12759-Z/TABLES/3

Ma, Y., Yin, J., Xuan, H., Ren, X., He, J., & Wang, T. (2024). Personality traits and family SES moderate the relationship between media multitasking and reasoning performance. *Journal of Intelligence 2024, 12*(6), 58. https://doi.org/10.3390/JINTELLIGENCE12060058

Magen, H. (2017). The relations between executive functions, media multitasking and polychronicity. *Computers in Human Behavior*, *67*, 1–9. https://doi.org/10.1016/J.CHB.2016.10.011

Manly, T., Robertson, I. H., Galloway, M., & Hawkins, K. (1999). The absent mind further investigations of sustained attention to response. *Neuropsychologia*, *37*(6), 661–670. https://doi.org/10.1016/S0028-3932(98)00127-4

Marty-Dugas, J., McHardy, R. J., Ralph, B. C. W., Kim, J., & Smilek, D. (2024). Active vs passive media multitasking and memory for lecture materials. *Heliyon*, *10*(11). https://doi.org/10.1016/j.heliyon.2024.e31935

Matthews, N., Mattingley, J. B., & Dux, P. E. (2022). Media-multitasking and cognitive control across the lifespan. *Scientific Reports, 12*(1), 1–10. https://doi.org/10.1038/s41598-022-07777-1

Mayl, J. J., Vaala, S. E., Patel, P. V., Ritter, M. B., & Richardson, K. M. (2023). Media multitasking in medical students: A theory-based approach to understanding this behavior. *Teaching and Learning in Medicine*, *35*(3), 265–276. https://doi.org/10.1080/10401334.2022.2056742

Minear, M., Brasher, F., McCurdy, M., Lewis, J., & Younggren, A. (2013). Working memory, fluid intelligence, and impulsiveness in heavy media multitaskers. *Psychonomic Bulletin and Review*, *20*(6), 1274–1281. https://doi.org/10.3758/s13423-013-0456-6

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

Monno, Y., Nawa, N. E., & Yamagishi, N. (2024). Duration of mood effects following a Japanese version of the mood induction task. *PLoS ONE*, *19*(1), e0293871. https://doi.org/10.1371/journal.pone.0293871

Mugon, J., Struk, A., & Danckert, J. (2018). A failure to launch: Regulatory modes and boredom proneness. *Frontiers in Psychology*, *9*, 307213. https://doi.org/10.3389/FPSYG.2018.01126/BIBTEX

Müller, S. M., Schiebener, J., Brand, M., & Liebherr, M. (2021). Decision-making, cognitive functions, impulsivity, and media multitasking expectancies in high versus low media multitaskers. *Cognitive Processing, 22*(4), 593–607. https://doi.org/10.1007/s10339-021-01029-2

Necka, E. A., Cacioppo, S., Norman, G. J., & Cacioppo, J. T. (2016). Measuring the prevalence of problematic respondent behaviors among MTurk, campus, and community participants. *PLoS ONE*, *11*(6). https://doi.org/10.1371/journal.pone.0157732

Nordahl, H., Anyan, F., & Hjemdal, O. (2023). Prospective relations between dysfunctional metacognitive beliefs, metacognitive strategies, and anxiety: Results from a four-wave longitudinal mediation model. *Behavior Therapy*, *54*(5), 765–776. https://doi.org/10.1016/J.BETH.2023.02.003

Ophir, E., Nass, C., & Wagner, A. D. (2009). Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences of the United States of America*, *106*(37), 15583–15587. https://doi.org/10.1073/PNAS.0903620106/ASSET/AD888EAA-9056-4490-89DF-91DEA2C29CD0/ASSETS/GRAPHIC/ZPQ9990993540003.JPEG

O'Leary, A. P., & Fletcher, W. (2024). Thinking about believing: Can metacognitive reflection encourage belief updating? *Journal of Intelligence, 12*(5)*,* 47. https://doi.org/10.3390/JINTELLIGENCE12050047

Parry, D. A., & le Roux, D. B. (2017). Off-task media use in lectures: Towards a theory of determinants. *Communications in Computer and Information Science*, *963*, 49–64. https://doi.org/10.1007/978-3-030-05813-5_4/FIGURES/1

Parry, D. A., & Le Roux, D. B. (2021). "Cognitive control in media multitaskers" ten years on: A meta-analysis. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, *15*(2), 2–7. https://doi.org/10.5817/CP2021

Pattyn, N., Neyt, X., Henderickx, D., & Soetens, E. (2008). Psychophysiological investigation of vigilance decrement: Boredom or cognitive fatigue? *Physiology and Behavior*, *93*(1–2), 369–378. https://doi.org/10.1016/j.physbeh.2007.09.016

Pea, R., Nass, C., Meheula, L., Rance, M., Kumar, A., Bamford, H., Nass, M., Simha, A., Stillerman, B., Yang, S., & Zhou, M. (2012). Media use, face-to-face communication, media multitasking, and social well-being among 8- to 12-year-old girls. *Developmental Psychology*, *48*(2), 327–336. https://doi.org/10.1037/a0027030

Ragan, E. D., Jennings, S. R., Massey, J. D., & Doolittle, P. E. (2014). Unregulated use of laptops over time in large lecture classes. *Computers & Education*, *78*, 78–86. https://doi.org/10.1016/J.COMPEDU.2014.05.002

Ralph, B. C. W., Seli, P., Wilson, K. E., & Smilek, D. (2020). Volitional media multitasking: Awareness of performance costs and modulation of media multitasking as a function of task demand. *Psychological Research*, *84*(2), 404–423. https://doi.org/10.1007/s00426-018-1056-x

Ralph, B. C. W., Smith, A. C., Seli, P., & Smilek, D. (2019). Yearning for distraction: Evidence for a trade-off between media multitasking and mind wandering. *Canadian Journal of Experimental Psychology*, *74*(1), 56. https://doi.org/10.1037/cep0000186

Ralph, B. C. W., Smith, A. C., Seli, P., & Smilek, D. (2021). The relation between task-unrelated media multitasking and task-related motivation. *Psychological Research*, *85*(1), 408–422. https://doi.org/10.1007/s00426-019-01246-7

Ralph, B. C. W., Thomson, D. R., Cheyne, J. A., & Smilek, D. (2014). Media multitasking and failures of attention in everyday life. *Psychological Research*, *78*(5), 661–669. https://doi.org/10.1007/s00426-013-0523-7

Rigby, J. M., Brumby, D. P., Gould, S. J. J., & Cox, A. L. (2017). Media multitasking at home: A video observation study of concurrent TV and mobile device usage. *TVX 2017 - Proceedings of the 2017 ACM International Conference on Interactive Experiences for TV and Online Video*, 3–10. https://doi.org/10.1145/3077548.3077560

Rioja, K., Cekic, S., Bavelier, D., & Baumgartner, S. E. (2023). Unravelling the link between media multitasking and attention across three samples. *Technology, Mind, and Behavior*, *4*(2), tmb0000106. https://doi.org/10.1037/TMB0000106

Risko, E. F., Anderson, N., Sarwal, A., Engelhardt, M., & Kingstone, A. (2012). Everyday attention: variation in mind wandering and memory in a lecture. *Applied Cognitive Psychology*, *26*(2), 234–242. https://doi.org/10.1002/acp.1814

Rouault, M., & Fleming, S. M. (2020). Formation of global self-beliefs in the human brain. *PNAS*, *117*(44), 27268–27276. https://doi.org/10.2307/26970907

Roberts, B. W., Jackson, J. J., Fayard, J. V., Edmonds, G., & Meints, J. (2009). Conscientiousness. In M. R. Leary & R. H. Hoyle (Eds.), *Handbook of individual differences in social behavior* (pp. 369–381). The Guilford Press.

Rogobete, D. A., Ionescu, T., & Miclea, M. (2020). The relationship between media multitasking behavior and executive function in adolescence: A replication study. *The Journal of Early Adolescence, 41*(5), 725-753. https://doi.org/10.1177/0272431620950478

Rosen, L. D., Mark Carrier, L., & Cheever, N. A. (2013). Facebook and texting made me do it: Media-induced task-switching while studying. *Computers in Human Behavior*, *29*(3), 948–958. https://doi.org/10.1016/J.CHB.2012.12.001

Ross, H. A., Russell, P. N., & Helton, W. S. (2014). Effects of breaks and goal switches on the vigilance decrement. *Experimental Brain Research*, *232*(6), 1729–1737. https://doi.org/10.1007/s00221-014-3865-5

Sanbonmatsu, D. M., Strayer, D. L., Medeiros-Ward, N., & Watson, J. M. (2013). Who multi-tasks and why? Multi-tasking ability, perceived multi-tasking ability, impulsivity, and sensation seeking. *PLoS ONE*, *8*(1). https://doi.org/10.1371/journal.pone.0054402

Sansevere, K. S., & Ward, N. (2021). Linking phubbing behavior to self-reported attentional failures and media multitasking. *Future Internet*, *13*(4). https://doi.org/10.3390/fi13040100

Schutten, D., Stokes, K. A., & Arnell, K. M. (2017). I want to media multitask and I want to do it now: Individual differences in media multitasking predict delay of gratification and system-1 thinking. *Cognitive Research: Principles and Implications*, *2*(1), 1–10. https://doi.org/10.1186/S41235-016-0048-X/FIGURES/2

Seli, P., Carriere, J. S. A., & Smilek, D. (2015). Not all mind wandering is created equal: Dissociating deliberate from spontaneous mind wandering. *Psychological Research*, *79*(5), 750–758. https://doi.org/10.1007/S00426-014-0617-X/TABLES/8

Seli, P., Risko, E. F., & Smilek, D. (2016). Assessing the associations among trait and state levels of deliberate and spontaneous mind wandering. *Consciousness and Cognition*, *41*, 50–56. https://doi.org/10.1016/J.CONCOG.2016.02.002

Seli, P., Schacter, D. L., Risko, E. F., & Smilek, D. (2019). Increasing participant motivation reduces rates of intentional and unintentional mind wandering. *Psychological Research*, *83*(5), 1057–1069. https://doi.org/10.1007/s00426-017-0914-2

Serpil, U. (2015). An analysis of the academic achievement of the students who listen to music while studying. *Educational Research and Reviews*, *10*(6), 728–732. https://doi.org/10.5897/err2014.1742

Shih, S. I. (2013). A null relationship between media multitasking and well-being. *PLoS ONE*, *8*(5). https://doi.org/10.1371/journal.pone.0064508

Shin, M., Linke, A., & Kemps, E. (2020). Moderate amounts of media multitasking are associated with optimal task performance and minimal mind wandering. *Computers in Human Behavior*, *111*, 106422. https://doi.org/10.1016/j.chb.2020.106422

Shin, M., & Murphy, K. (2025). Frequent media use, media multitasking, and perceived cost of cognitive effort. *Cyberpsychology, Behavior, and Social Networking, 28*(5), 354-358. https://doi.org/10.1089/cyber.2024.0492

Shin, M., Taseski, D., & Murphy, K. (2024). Media multitasking is linked to attentional errors, mind wandering and automatised response to stimuli without full conscious processing. *Behaviour & Information Technology*, *43*(3), 445–457. https://doi.org/10.1080/0144929X.2023.2167669

Shin, M., Webb, A., & Kemps, E. (2019). Media multitasking, impulsivity and dual task ability. *Computers in Human Behavior*, *92*, 160–168. https://doi.org/10.1016/j.chb.2018.11.018

Shukla, S. (2021). Relationship between Big Five personality traits and media multitasking behavior of the Indian sample. *Cultural-Historical Psychology*, *17*(1), 50–58. https://doi.org/10.17759/chp.2021170108

Smit, A. S., Eling, P. A. T. M., & Coenen, A. M. L. (2004). Mental effort causes vigilance decrease due to resource depletion. *Acta Psychologica*, *115*(1), 35–42. https://doi.org/10.1016/j.actpsy.2003.11.001

Stavrinos, D., Jones, J. L., Garner, A. A., Griffin, R., Franklin, C. A., Ball, D., Welburn, S. C., Ball, K. K., Sisiopiku, V. P., & Fine, P. R. (2013). Impact of distracted driving on safety and traffic flow. *Accident Analysis and Prevention*, *61*, 63–70. https://doi.org/10.1016/j.aap.2013.02.003

Struk, A. A., Carriere, J. S. A., Cheyne, J. A., & Danckert, J. (2017). A short boredom proneness scale: development and psychometric properties. *Assessment*, *24*(3), 346–359. https://doi.org/10.1177/1073191115609996

Struk, A. A., Scholer, A. A., Danckert, J., & Seli, P. (2020). Rich environments, dull experiences: How environment can exacerbate the effect of constraint on the experience of boredom. *Cognition and Emotion*, *34*(7), 1517–1523. https://doi.org/10.1080/02699931.2020.1763919

Tam, K. Y. Y., & Inzlicht, M. (2024). Fast-forward to boredom: How switching behavior on digital media makes people more bored. *Journal of Experimental Psychology: General*, *153*(10), 2409–2426. https://doi.org/10.1037/xge0001639.supp

Tam, K. Y. Y., van Tilburg, W. A. P., & Chan, C. S. (2021). What is boredom proneness? A comparison of three characterizations. *Journal of Personality*, *89*(4), 831–846. https://doi.org/10.1111/jopy.12618

Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality*, *72*(2), 271–324. https://doi.org/10.1111/j.0022-3506.2004.00263.x

Tassone, A., Liu, J. J. W., Reed, M. J., & Vickers, K. (2020). Multitasking in the classroom: Testing an educational intervention as a method of reducing multitasking. *Active Learning in Higher Education*, *21*(2), 128–141. https://doi.org/10.1177/1469787417740772

Thomson, D. R., Besner, D., & Smilek, D. (2015). A resource-control account of sustained attention: Evidence from mind-wandering and vigilance paradigms. *Perspectives on Psychological Science*, *10*(1), 82–96. https://doi.org/10.1177/1745691614556681

Thomson, D. R., Seli, P., Besner, D., & Smilek, D. (2014). On the link between mind wandering and task performance over time. *Consciousness and Cognition*, *27*(1), 14–26. https://doi.org/10.1016/j.concog.2014.04.001

Toyama, M., & Hayashi, Y. (2022). Links of personality traits to media multitasking: Conscientiousness predicts mobile phone use in the college classroom. *Current Psychology*, *41*(12), 8660–8667. https://doi.org/10.1007/S12144-020-01258-2/TABLES/2

Toyama, M., & Hayashi, Y. (2023). Personality and media multitasking in the college classroom: Context-dependent implications of conscientiousness and agreeableness. *Current Psychology*, *42*(6), 4391–4399. https://doi.org/10.1007/S12144-021-01793-6/TABLES/2

Uncapher, M. R., K. Thieu, M., & Wagner, A. D. (2016). Media multitasking and memory: Differences in working memory and long-term memory. *Psychonomic Bulletin and Review*, *23*(2), 483–490. https://doi.org/10.3758/S13423-015-0907-3/FIGURES/3

Vannucci, M., & Chiorri, C. (2018). Individual differences in self-consciousness and mind wandering: Further evidence for a dissociation between spontaneous and deliberate mind wandering. *Personality and Individual Differences*, *121*, 57–61. https://doi.org/10.1016/J.PAID.2017.09.022

Voinea, G. D., Boboc, R. G., Buzdugan, I. D., Antonya, C., & Yannis, G. (2023). Texting while driving: A literature review on driving simulator studies. *International Journal of Environmental Research and Public Health, 20*(5), 4354. https://doi.org/10.3390/IJERPH20054354

Voorveld, H. A. M., & Viswanathan, V. (2015). An observational study on how situational factors influence media multitasking with TV: The role of genres, dayparts, and social viewing. *Media Psychology*, *18*(4), 499–526. https://doi.org/10.1080/15213269.2013.872038

Wammes, J. D., Ralph, B. C. W., Mills, C., Bosch, N., Duncan, T. L., & Smilek, D. (2019). Disengagement during lectures: Media multitasking and mind wandering in university classrooms. *Computers & Education*, *132*, 76–89. https://doi.org/10.1016/J.COMPEDU.2018.12.007

Wang, Z., Irwin, M., Cooper, C., & Srivastava, J. (2015). Multidimensions of media multitasking and adaptive media selection. *Human Communication Research*, *41*(1), 102–127. https://doi.org/10.1111/HCRE.12042

Wang, Z., & Tchernev, J. M. (2012). The "'myth"' of media multitasking: Reciprocal dynamics of media multitasking, personal needs, and gratifications. *Journal of Communication* , *62*, 493–513. https://doi.org/10.1111/j.1460-2466.2012.01641.x

Warm, J. S., Parasuraman, R., & Matthews, G. (2008). Vigilance requires hard mental work and is stressful. *Human Factors, 50*(3), 433-441. https://doi.org/10.1518/001872008X312152

Watt, J. D., & Vodanovich, S. J. (1992). Relationship between boredom proneness and impulsivity. *Psychological Reports*, *70*(3), 688–690. https://doi.org/10.2466/pr0.1992.70.3.688

Wiradhany, W., & Koerts, J. (2021). Everyday functioning-related cognitive correlates of media multitasking: a mini meta-analysis. *Media Psychology*, *24*(2), 276–303. https://doi.org/10.1080/15213269.2019.1685393

Wiradhany, W., & Nieuwenstein, M. R. (2017). Cognitive control in media multitaskers: Two replication studies and a meta-Analysis. *Attention, Perception, and Psychophysics*, *79*(8), 2620–2641. https://doi.org/10.3758/S13414-017-1408-4/FIGURES/16

Wiradhany, W., van Vugt, M. K., & Nieuwenstein, M. R. (2020). Media multitasking, mind-wandering, and distractibility: A large-scale study. *Attention, Perception, and Psychophysics*, *82*(3), 1112–1124. https://doi.org/10.3758/s13414-019-01842-0

Wolff, W., Bieleke, M., Englert, C., Bertrams, A., Schüler, J., & Martarelli, C. S. (2022). A single item measure of self-control – validation and location in a nomological network of self-control, boredom, and if-then planning. *Social Psychological Bulletin*, *17*(1). https://doi.org/10.32872/spb.7453

Wushe, T., & Shenje, J. (2019). The relationship between social media usage in the workplace and employee productivity in the public sector: Case study of government departments in Harare. *SA Journal of Human Resource Management*, *17*. https://doi.org/10.4102/SAJHRM.V17I0.1116

Xu, S., & David, P. (2018). Distortions in time perceptions during task switching. *Computers in Human Behavior*, *80*, 362–369. https://doi.org/10.1016/j.chb.2017.11.032

Xu, S., Wang, Z., & David, P. (2016). Media multitasking and well-being of university students. *Computers in Human Behavior*, *55*, 242–250. https://doi.org/10.1016/j.chb.2015.08.040

Yang, X., Xu, X., & Zhu, L. (2015). Media multitasking and psychological wellbeing in Chinese adolescents: Time management as a moderator. *Computers in Human Behavior*, *53*, 216–222. https://doi.org/10.1016/J.CHB.2015.06.034

Yang, X., & Zhu, L. (2016). Predictors of media multitasking in Chinese adolescents. *International Journal of Psychology*, *51*(6), 430–438. https://doi.org/10.1002/IJOP.12187

Yanko, M. R., & Spalek, T. M. (2014). Driving with the wandering mind: The effect that mind-wandering has on driving performance. *Human Factors*, *56*(2), 260–269. https://doi.org/10.1177/0018720813495280

Yildirim, C., & Dark, V. J. (2018). The mediating role of mindfulness in the relationship between media multitasking and mind wandering. *ACM International Conference Proceeding Series*, *18*. https://doi.org/10.1145/3183654.3183711

Zwarun, L., & Hall, A. (2014). What's going on? Age, distraction, and multitasking during online survey taking. *Computers in Human Behavior*, *41*, 236–244. https://doi.org/10.1016/J.CHB.2014.09.041

Appendix A

Additional Chapter 3.2 Analyses Based on Responses to the Extra-Experimental Media Multitasking Question

Chapter 3.2 Results Excluding Participants Who Engaged in Activities Outside the Experimental Context

Data Preprocessing

After applying the data preprocessing methods employed in Ralph et al. (2021), which involved removing participants with less than 30% hits and greater than 20% false alarms, the data was filtered so that only participants who responded "No" to the question, "Were you engaged in any tasks other than those related to the experiment?" remained. The final sample consisted of 169 participants (137 women, 27 men, 2 genderqueer, 1 agender and 2 who preferred not to answer), with 71 participants in the Control condition and 98 participants in the Motivated condition. Based on the 168 complete responses to the age question, the age of the sample ranged from 17 to 44 years old (M_{age} = 20.22, SD = 3.78).

Motivation

Pre- and post-task ratings of motivation were examined using a mixed factorial ANOVA with condition (Motivated or Control) as a between-participants factor and time (Pre- or Post-Task) as a within-participants factor. The main effect of condition neared, but did not reach significance, $F(1, 167) = 3.78$, $p = .053$, , $\eta^2_p = .02$; however, there was a main effect of time, $F(1, 167) = 128.81$, $p < .001$, $\eta^2_p = .44$, with motivation levels decreasing from the start to the end of

the task (Figure A1). There was no significant interaction between condition and time, $F(1, 167) = 1.54$, $p = .217$, $\eta^2_p = .01$.

Changes in motivation over the course of the 1-back task were analyzed using a mixed factorial ANOVA with condition as a between-participants factor and block (the nine probes in the 1-back) as a within-participants factor. Two participants with missing responses on one or more of the probes were removed from this analysis. Mauchly's test indicated that the assumption of sphericity was violated ($W = 0.05$, $p < .001$), therefore, results are presented after applying a Greenhouse-Geisser correction ($\varepsilon = 0.50$). There was a significant main effect of condition, $F(1, 161) = 8.74$, $p = .004$, $\eta^2_p = .05$, indicating that participants in the Motivated condition were significantly more motivated than those in the Interest condition. There was also a main effect of block, $F(4.04, 649.92) = 74.30$, $p < .001$, $\eta^2_p = 0.32$, with motivation decreasing over the course of the task. The interaction between condition and block was not significant, $F(4.04, 649.92) = 1.90$, $p = .108$, $\eta^2_p = 0.01$ (Figure A1).

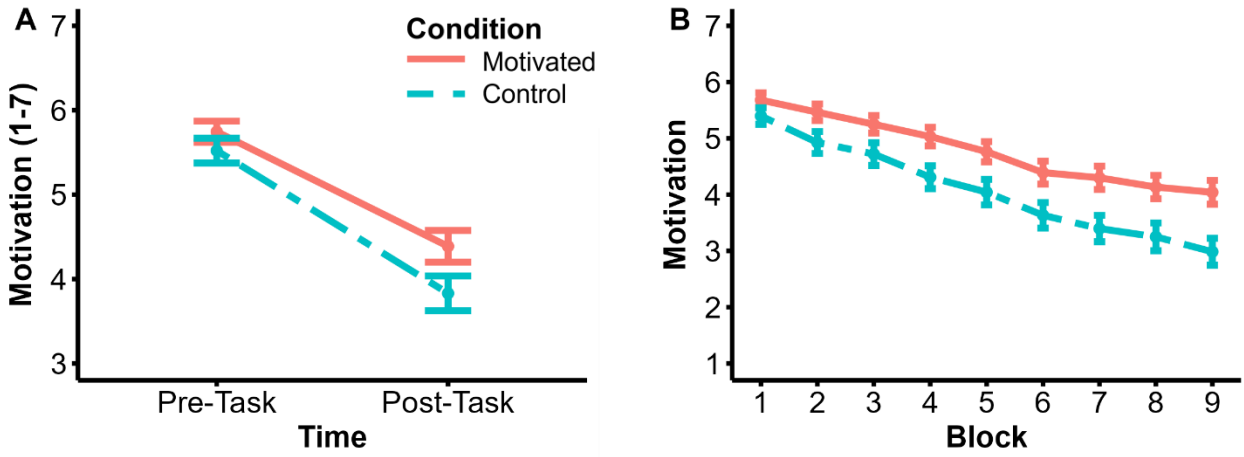


Figure A1. Graphs depicting mean levels of motivation before and after the 1-back (A) as well as over successive blocks of the 1-back (B) as a function of condition. Error bars represent +/- 1 Standard Error of the Mean.

Motivation-related Experiences

Participants in the Motivated (M = 2.95, SD = 1.45) and Control (M = 2.90, SD = 1.57) conditions did not differ in terms of their enjoyment of the 1-back, $t(167) = 0.20$, $p = .839$, $d = .03$ or how interesting they found the task, $t(167) = 0.02$, $p = .984$, $d = .00$ ($M_{Motivated} = 2.64$, $SD_{Motivated} = 1.53$; $M_{Control} = 2.65$, $SD_{Control} = 1.76$). Overall, participants in the Motivated condition reported that they were motivated by the instructions informing them that they could leave the task early, scoring near the midpoint on the 7-point Likert scale (M = 5.54, SD = 1.57), where 1 represented "not at all motivated" and 7 represented "very motivated".

Impact of Motivation Manipulation on Media Multitasking

The trials of the 1-back were divided into nine blocks of 52 trials, corresponding to the number of motivation probes included in the task. Within each block, the number of trials participants spent with the video on was summed. Changes in media multitasking as a function of time and condition were assessed using a GLMM, with condition (Control as the reference group) and block (standardized) as fixed effects, and intercepts and slopes that were allowed to vary randomly by participant and block. A Poisson distribution was specified for the outcome variable (media multitasking). Results of the GLMM are shown in Table A1 and changes in media multitasking over time are plotted for both conditions in Figure A2. There was a significant effect of condition such that those in the Motivated condition were less likely to media multitask than those in the Control condition. There was no significant effect of block, and there was no interaction between condition and block.

Table A1.

GLMM results with Block, Condition and Their Interaction Predicting Media Multitasking

Fixed Effects	Estimate	SE	z	p
Intercept	-0.41	0.62	-0.66	.508
Condition (Motivated Group)	-3.03	0.83	-3.65	< .001
Block	-0.07	0.21	-0.34	.732
Block*Condition	-0.44	0.24	-1.81	.071

Note. N = 169. Coefficients for the effect of condition are shown for the Motivated condition (Control is the reference condition). *P*-values are based on Wald-z tests comparing estimates against zero.

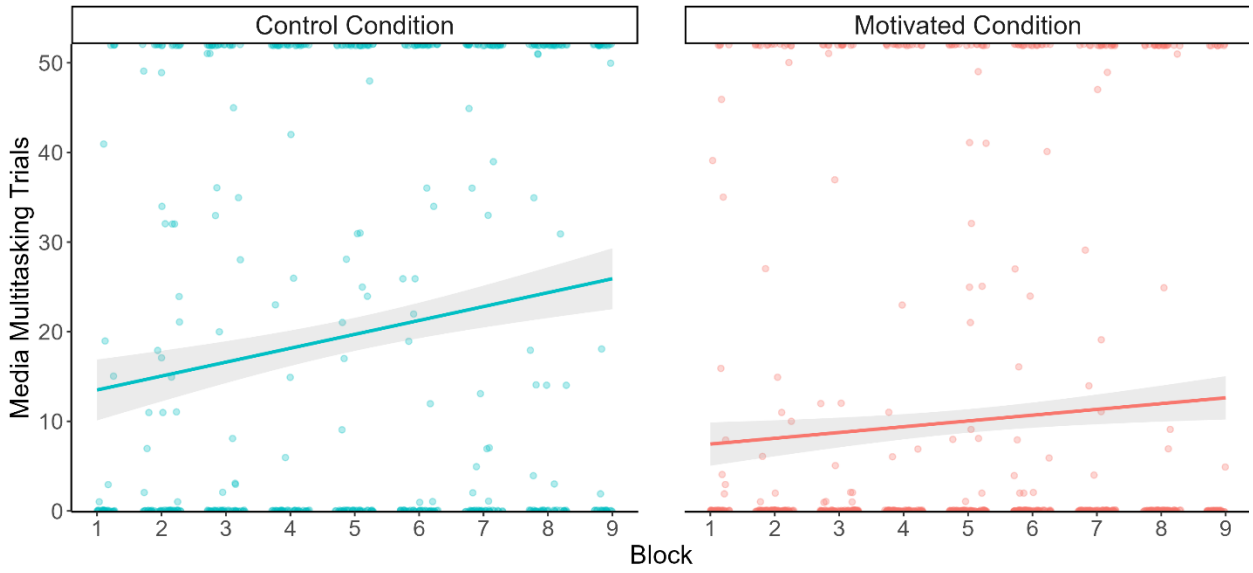


Figure A2. Scatterplots depicting changes in media multitasking over successive blocks of the 1-back for participants in the Control condition (left) and Motivated condition (right). Data points are jittered to increase their visibility. Regression lines are fitted to the data and shading represents 95% confidence intervals.

Changes in Performance Over Time

Proportion of hits and false alarms were calculated for each of the nine blocks of the 1-back (Figure A3) and changes in performance over time were evaluated using mixed factorial ANOVAs with either proportion of hits or proportion of false alarms as the dependent variable, condition as a between-participants factor and block as a within-participants factor. Mauchly's tests indicated that the assumption of sphericity was violated for the ANOVAs involving both proportion of hits ($W = 0.18$, $p < .001$) and proportion of false alarms ($W = 0.39$, $p < .001$). Results are therefore presented using Greenhouse-Geisser estimates of sphericity ($\varepsilon_{\textit{proportion hits}} = 0.60$, $\varepsilon_{\textit{proportion false alarms}} = 0.78$).

Concerning proportion of hits, there was a main effect of condition, $F(1, 167) = 5.11$, $p = .025$, $\eta^2_p = .03$, indicating that proportion of hits were higher in the Motivated condition compared to the Control condition. Additionally, there was a main effect of block, $F(4.80, 802.14) = 24.71$, $p < .001$, $\eta^2_p = .13$, such that proportion of hits declined over time. There was no significant interaction between condition and block, $F(4.80, 802.14) = 1.98$, $p = .082$, $\eta^2_p = .01$. Proportion of false alarms were at floor and no main effect of condition, $F(1, 167) = 0.06$, $p = .806$, $\eta^2_p < .01$, or block, $F(6.23, 1039.87) = 0.52$, $p = .796$, $\eta^2_p < .01$, was found. Moreover, there was no interaction between condition and block, $F(6.23, 1039.87) = 0.75$, $p = .615$, $\eta^2_p < .01$.

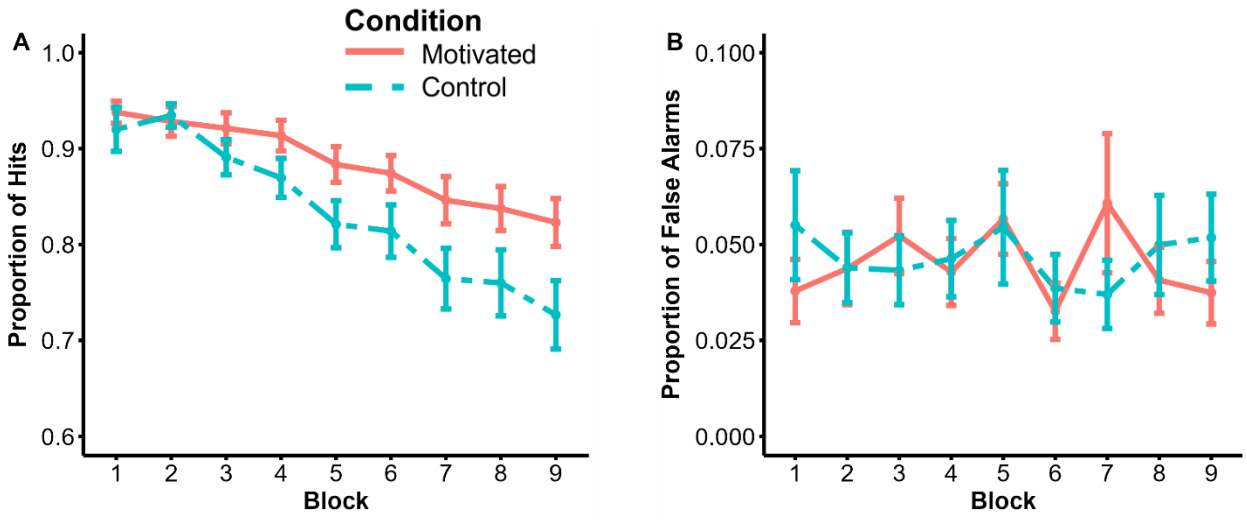


Figure A3. Line graphs depicting proportion of hits (A) and proportion of false alarms (B) over successive blocks of the 1-back for participants in the Motivated and Control condition. Error bars represent +/- 1 standard error of the mean.

Chapter 3.2 Results Including Only Participants Who Engaged in Activities Outside the Experimental Context

Data Preprocessing

After applying the data preprocessing methods employed in Ralph et al. (2021), which involved removing participants with less than 30% hits and greater than 20% false alarms, the data so were filtered so that only participants who responded "Yes" to the question, "Were you engaged in any tasks other than those related to the experiment?" remained. The final sample consisted of 113 participants (93 women, 17 men, 3 genderqueer), with 57 participants in the Control condition and 56 participants in the Motivated condition. Based on the 105 complete responses to the age question, the age of the sample ranged from 17 to 33 years old (M_{age} = 19.67, SD = 2.73).

Motivation

Pre- and post-task ratings of motivation were compared using a mixed factorial ANOVA with condition (Motivated or Control) as a between-participants factor and time (Pre- or Post-Task) as a within-participants factor. There was no main effect of condition, $F(1, 1111) = 0.02$, $p = .894$, $\eta^2_p < .01$; however, there was a main effect of time, $F(1, 111) = 101.79$, $p < .001$, $\eta^2_p = .48$, with motivation levels decreasing from the start to the end of the task (Figure A4). There was no interaction between condition and time, $F(1, 111) = 1.18$, $p = .280$, $\eta^2_p = .01$.

Changes in motivation over the course of the 1-back task were examined using a mixed factorial ANOVA with condition as a between-participants factor and block (corresponding to the nine probes in the 1-back) as a within-participants factor. Five participants with missing responses on one or more of the probes were removed from this analysis. As Mauchly's test indicated that the assumption of sphericity was violated ($W = 0.03$, $p < .001$), results are presented after applying a Greenhouse-Geisser correction ($\varepsilon = 0.42$). There was no main effect of condition, $F(1, 105) = 0.83$, $p = .363$, $\eta^2_p = .01$, although there was a main effect of block, $F(3.34, 350.64) = 61.97$, $p < .001$, $\eta^2_p = .37$, with motivation decreasing over the course of the task. The interaction between condition and block was not significant, $F(3.34, 350.64) = 1.27$, $p = .283$, $\eta^2_p = .01$ (Figure A4).

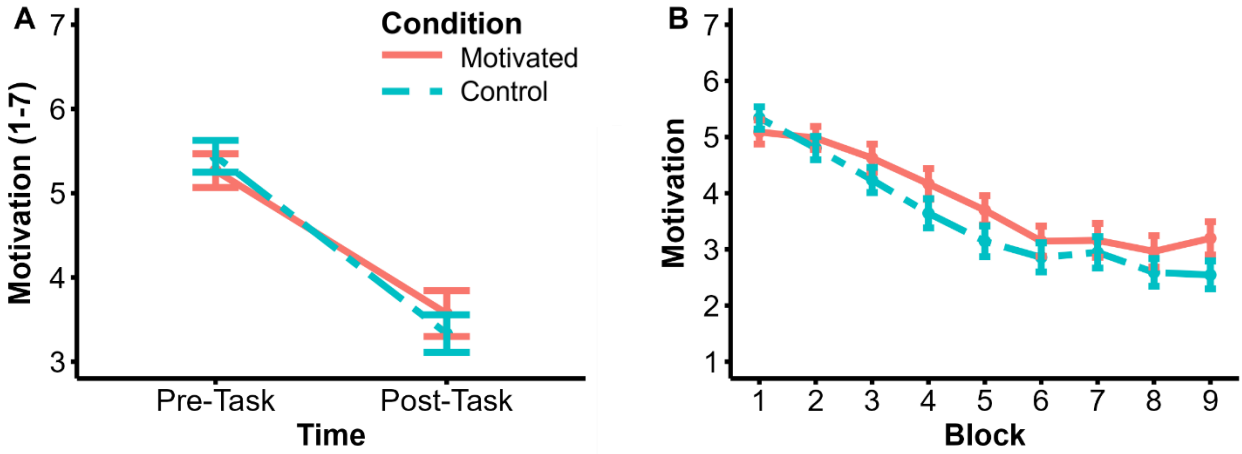


Figure A4. Graphs depicting mean levels of motivation before and after the 1-back (A) as well as over successive blocks of the 1-back (B) as a function of condition. Error bars represent +/- 1 standard error of the mean.

Motivation-related Experiences

Participants in the Motivated (M = 2.21, SD = 1.42) and Control (M = 2.32, SD = 1.45) conditions did not differ in terms of their enjoyment of the 1-back, $t(111) = 0.37$, $p = .708$, $d = .07$ or how interesting they found the task, $t(111) = 0.98$, $p = .328$, $d = .18$ ($M_{Motivated} = 1.93$, $SD_{Motivated} = 1.39$; $M_{Control} = 2.18$, $SD_{Control} = 1.28$). Overall, participants in the Motivated condition reported that they were motivated by the instructions informing them that they could leave the task early, scoring near the midpoint on the 7-point Likert scale (M = 4.88, SD = 2.07), where 1 represented "not at all motivated" and 7 represented "very motivated".

Impact of Motivation Manipulation on Media Multitasking

The trials of the 1-back were divided into nine blocks of 52 trials to correspond to the number of probes included in the 1-back. The total number of trials during which participants

engaged in media multitasking was calculated for each block. Changes in media multitasking as a function of time and condition were assessed using a GLMM, with condition (Control as the reference group) and block (standardized) as fixed effects, and intercepts and slopes that were allowed to vary randomly by participant and block. A Poisson distribution was specified for the outcome variable (media multitasking). Results of the GLMM are shown in Table A2 and changes in media multitasking over time are plotted for both conditions in Figure A5. There was a significant effect of condition such that those in the Motivated condition were less likely to media multitask than those in the Control condition. There was no significant effect of block nor was there a significant interaction between Condition and Block.

Table A2.

GLMM results with Block, Condition and Their Interaction Predicting Media Multitasking

Fixed Effects	Estimate	SE	z	p
Intercept	0.22	0.52	0.43	.668
Condition (Motivated Group)	-1.62	0.75	-2.16	.031
Block	0.18	0.16	1.13	.259
Block*Condition	-0.19	0.21	-0.94	.347

Note. N = 113. Coefficients for the effect of condition are shown for the Motivated condition (Control is the reference condition). *P*-values are based on Wald z-tests comparing estimates against zero.

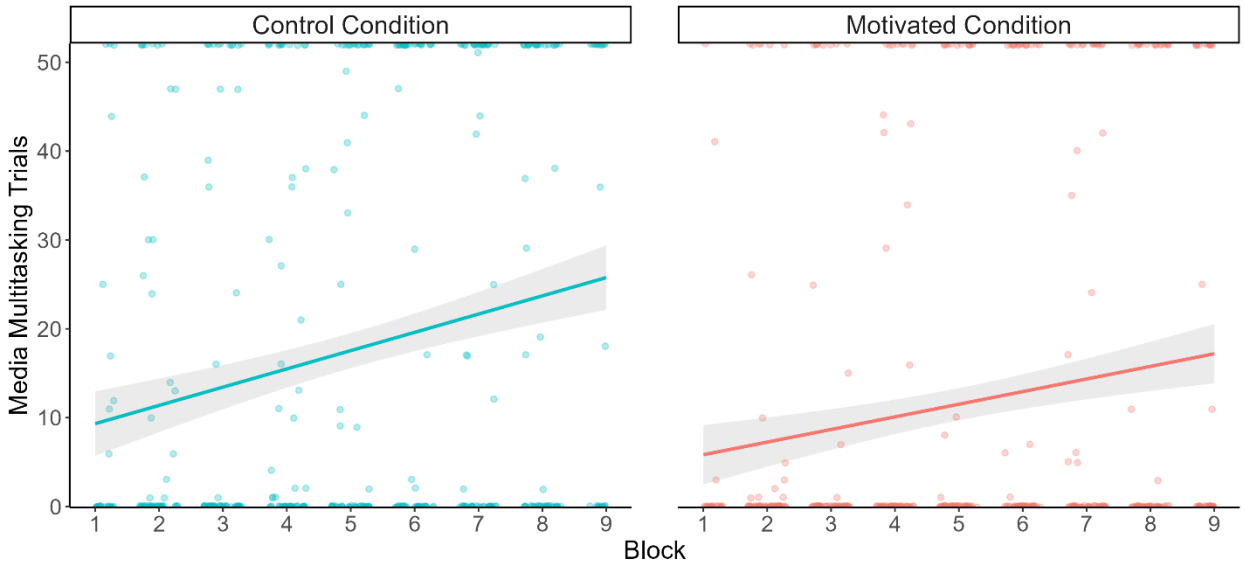


Figure A5. Scatterplots depicting changes in media multitasking over successive blocks of the 1-back for participants in the Control condition (left) and Motivated condition (right). Data points are jittered to increase their visibility. Regression lines are fitted to the data and shading represents 95% confidence intervals.

Changes in Performance Over Time

Proportion of hits and false alarms were calculated for each of the nine blocks of the 1-back (Figure A6) and changes in performance over time were evaluated using mixed factorial ANOVAs with either proportion of hits or proportion of false alarms as the dependent variable, condition as a between-participants factor and block as a within-participants factor. Mauchly's tests indicated that the assumption of sphericity was violated for the ANOVAs involving both proportion of hits ($W = 0.10$, $p < .001$) and proportion of false alarms ($W = 0.50$, $p < .001$). Results are therefore presented using Greenhouse-Geisser estimates of sphericity ($\varepsilon_{\textit{proportion hits}} = 0.54$, $\varepsilon_{\textit{proportion false alarms}} = 0.87$).

Concerning proportion of hits, there was no main effect of condition, $F(1, 111) = 3.02$, $p = .085$, $\eta^2_p = .03$. There was a main effect of block, $F(4.31, 478.13) = 33.55$, $p < .001$, $\eta^2_p = .23$, such that proportion of hits declined over time. There was a significant interaction between condition and block, $F(4.31, 478.13) = 2.66$, $p = .029$, $\eta^2_p = .02$. Proportion of false alarms were at floor and no main effect of condition, $F(1, 111) = 0.23$, $p = .631$, $\eta^2_p < .01$, or block, $F(6.95, 771.12) = 1.18$, $p = .314$, $\eta^2_p = .01$, was found. Moreover, there was no interaction between condition and block, $F(6.95, 771.12) = 0.96$, $p = .458$, $\eta^2_p = .01$.

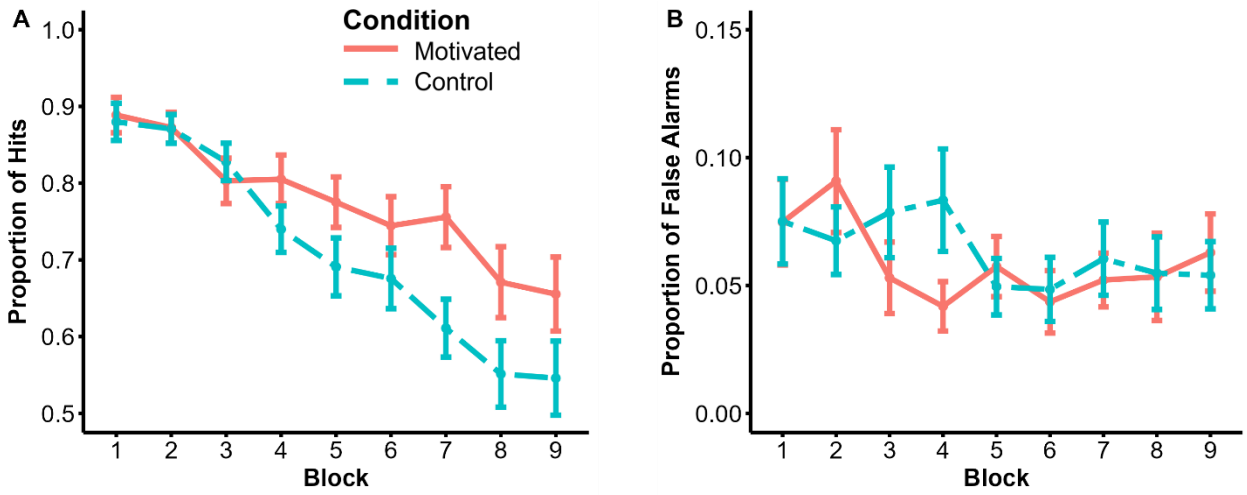


Figure A6. Line graphs depicting proportion of hits (A) and proportion of false alarms (B) over successive blocks of the 1-back for participants in the Motivated and Control condition. Error bars represent +/- 1 standard error of the mean.

Appendix B

Additional Chapter 3.2 Analyses Based on Responses to the Extra-Experimental Media Multitasking Question Using the Approach Taken in Chapter 2

Data Preprocessing and Analyses

The same performance filters applied throughout the thesis, which involved removing participants with less than 30% hits and greater than 20% false alarms, were applied to the present data. Participants were then coded as belonging to the Extra-Experimental MMT group if they reported engaging in other media-related activities during the study or to the No MMT group if they indicated that they did not engage in outside activities and never played the optional video during the study. Participants who did not meet these criteria were omitted from these exploratory analyses. The final sample consisted of 159 participants, with 94 belonging to the Extra-Experimental MMT group and 65 belonging to the No MMT group. Based on the 156 complete responses to the age question, the average age of the sample was 19.95 (SD = 3.63), with ages ranging between 17 and 43. As participants who multitasked with the video were not included in the No MMT group, analyses cannot compare media multitasking with the optional video across the Extra-Experimental MMT and No MMT conditions. Therefore, comparisons between groups focused only on ratings of motivation and changes in performance over time. Where the assumption of sphericity was violated, a Greenhouse Geisser correction was applied to the degrees of freedom.

Motivation

Pre- and post-task ratings of motivation were compared using a mixed factorial ANOVA with Extra-Experimental MMT group (Extra-Experimental MMT or No MMT) as a between-

participants factor and time (pre- versus post-task) as a within-participants factor. There was a main effect of group, $F(1, 157) = 16.97$, $p < .001$, $\eta^2_p = .10$, indicating that motivation levels were higher among those in the No MMT group compared to the Extra-Experimental MMT group. There was also as a main effect of time, $F(1, 157) = 102.25$, $p < .001$, $\eta^2_p = .39$, with motivation levels decreasing from the start to the end of the task (Figure B1), and an interaction between group and time, $F(1, 157) = 10.11$, $p = .002$, $\eta^2_p = .06$, indicating that motivation levels decreased more steeply for those in the Extra-Experimental MMT versus No MMT group.

Changes in motivation over the course of the 1-back task were examined using a mixed factorial ANOVA with Extra-Experimental MMT group as a between-participants factor and block (corresponding to the nine probes in the 1-back) as a within-participants factor. Six participants with missing responses on one or more of the probes were removed from this analysis. There was a main effect of group, $F(1, 151) = 26.86$, $p < .001$, $\eta^2_p = .15$, such that motivation levels were higher among those in the No MMT group compared to the Extra-Experimental MMT condition. There was also a main effect of block, $F(3.32, 502.03) = 59.56$, $p < .001$, $\eta^2_p = .28$, with motivation levels decreasing over time, and an interaction between group and block, $F(3.32, 502.03) = 5.64$, $p < .001$, $\eta^2_p = .04$, such that motivation levels declined more steeply in the Extra-Experimental MMT group relative to the No MMT group (Figure B1).

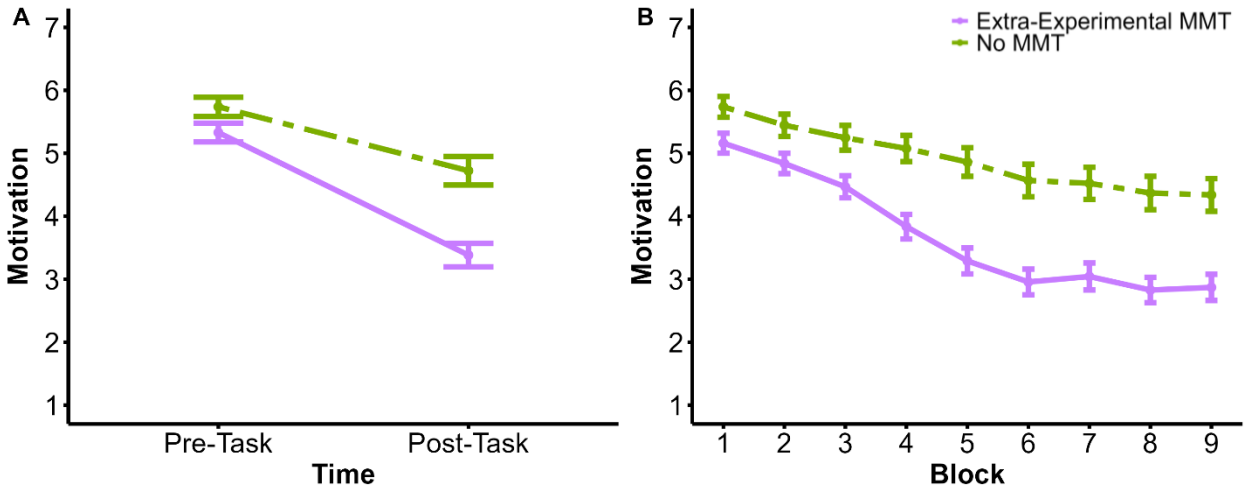


Figure B1. (A) Mean (±SE) ratings of motivation pre- and post task and (B) over successive blocks of the 1-back task for participants in the Extra-Experimental MMT and No MMT groups.

Motivation-related Experiences

Participants in the No MMT group (M = 3.17, SD = 1.46) found the 1-back task significantly more enjoyable than participants in the Extra-Experimental MMT group (M = 2.23, SD = 1.41), $t(157) = -4.05$, $p < .001$, $d = .65$. The 1-back task was also rated as more interesting by participants in the No MMT group (M = 2.78, SD = 1.67) compared to participants in the Extra-Experimental MMT group (M = 2.00, SD = 1.32), $t(157) = -3.30$, $p = .001$, $d = 0.53$.

Changes in Performance Over Time

Proportion of hits and false alarms were calculated for each of the nine blocks of the 1-back (Figure B2) and changes in performance over time were evaluated using mixed factorial ANOVAs with either proportion of hits or proportion of false alarms as the dependent variable, Extra-Experimental MMT group as a between-participants factor and block as a within-participants factor.

Concerning proportion of hits, there was a main effect of Extra-Experimental MMT group, $F(1, 157) = 50.88$, $p < .001$, $\eta^2_p = .25$ such that hit rates were higher among those in the No MMT group compared to the Extra-Experimental MMT group. There was also a main effect of block, $F(4.21, 661.36) = 24.95$, $p < .001$, $\eta^2_p = .14$, revealing that proportion of hits declined over time, as well as a significant interaction between group and block, $F(4.21, 661.36) = 9.69$, $p < .001$, $\eta^2_p = .06$, indicating that participants in the Extra-Experimental MMT group exhibited steeper declines in proportion of hits over time relative to those in the No MMT group. Regarding proportion of false alarms, there was a main effect of group, $F(1, 157) = 6.76$, $p = .010$, $\eta^2_p = .04$, with false alarms occurring more frequently in the Extra-Experimental MMT group compared to the No MMT group. There was no main effect of block, $F(7.34, 1151.98) = 0.63$, $p = .742$, $\eta^2_p < .01$, and no interaction between group and block, $F(7.34, 1151.98) = 0.80$, $p = .589$, $\eta^2_p = .01$.

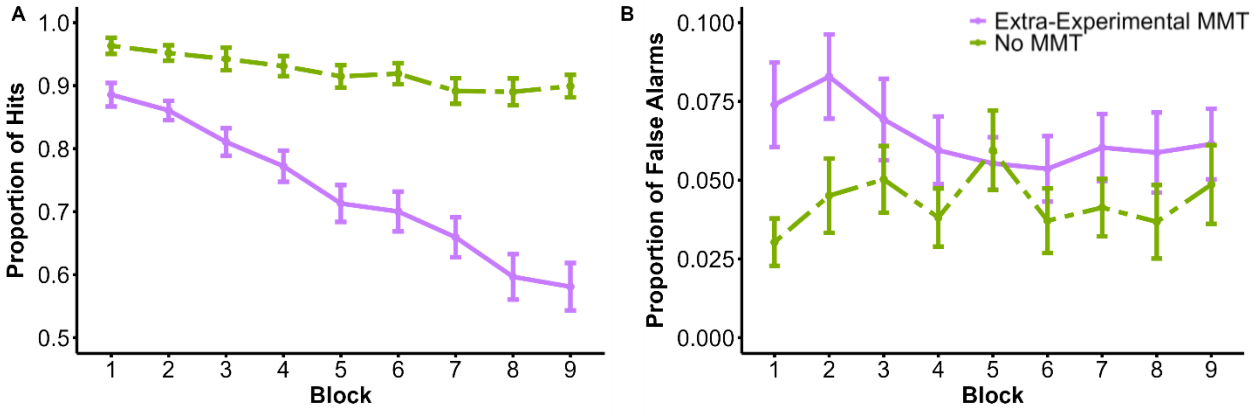


Figure B2. Mean (±SE) proportion of hits (A) and proportion of false alarms (B) over successive blocks of the 1-back task for participants in the Extra-Experimental MMT and No MMT groups.

Appendix C

Additional Analyses for Chapter 4

Correlations Between Individual Difference Measures

Table C1.

Correlations Between Individual Difference Measures

	Attention-related cognitive errors	Attention lapses	Spontaneous mind-wandering	Deliberate mind-wandering	Conscientiousness	Self-control	Boredom Proneness	Short Media Multitasking Measure
Attention lapses	.56***							
Spontaneous mind-wandering	.47***	.45***						
Deliberate mind-wandering	.11	.12	.36***					
Conscientiousness	-.39***	-.40***	-.34***	-.09				
Self-control	-.50***	-.51***	-.49***	-.12	.70***			
Boredom Proneness	.48***	.50***	.44***	.01	-.61***	-.64***		
Short Media Multitasking Measure	.20*	.18*	.16*	.03	-.26**	.24**	.28***	
Media Multitasking Index	.36**	.30*	.14	.20	-.20	.25	.32*	.66***

Note. For all correlations except those involving the media multitasking questionnaires, $N = 156$. For correlations involving the Short Media Multitasking Measure, $N = 153$, and for correlations involving the Media Multitasking Index, $N = 56$.

Individual Difference Scores Based on Post-Task Responses Using Chapter 2 Approach

To follow the methods used in Chapter 2 of comparing participants who did an did not engage in extra-experimental media multitasking, participants were divided into those who engaged with media-related content outside the experimental context (Extra-Experimental MMT group, $n = 61$) and those who refrained from multitasking, either with outside activities or the optional video provided during the 1-back task (No MMT group, $n = 85$). A series of independent samples *t*-tests were then conducted to determine whether scores on the individual difference measures differed between groups. Note that the degrees of freedom differ across *t*-tests depending on the number of participants who provided complete responses on the scales. No significant differences were found for scores on the Attention-Related Cognitive Errors scale, Deliberate Mind-Wandering Scale, Conscientiousness scale or Brief Self-Control Scale ($ps < .05$). However, scores on the Lapses-Only variant of the Mindful Attention Awareness scale were higher among those who engaged in extra-experimental media multitasking ($M = 43.87$, $SD = 7.94$) compared to those who refrained from multitasking altogether ($M = 40.21$, $SD = 9.41$), $t(144) = 2.47$, $p = .015$, $d = 0.41$. The same was true of scores on the Spontaneous Mind-Wandering Scale ($M_{Extra\text{-}Experimental\ MMT} = 5.03$, $SD_{Extra\text{-}Experimental\ MMT} = 1.40$, $M_{No\ MMT} = 4.50$, $SD_{No\ MMT} = 1.36$), $t(144) = 2.30$, $p = .023$, $d = 0.39$, Short Boredom Proneness Scale ($M_{Extra\text{-}Experimental\ MMT} = 32.18$, $SD_{Extra\text{-}Experimental\ MMT} = 10.01$, $M_{No\ MMT} = 28.06$, $SD_{No\ MMT} = 9.47$), $t(144) = 2.53$, $p = .012$, $d = 0.43$, Short Media Multitasking Measure ($M_{Extra\text{-}Experimental\ MMT} = 2.53$, $SD_{Extra\text{-}Experimental\ MMT} = 0.61$, $M_{No\ MMT} = 2.25$, $SD_{No\ MMT} = 0.62$), $t(149) = 2.74$, $p = .007$, $d = 0.45$, and Media Multitasking Index ($M_{Extra\text{-}Experimental\ MMT} = 3.75$, $SD_{Extra\text{-}Experimental\ MMT} = 2.07$, $M_{No\ MMT} = 2.59$, $SD_{No\ MMT} = 1.52$), $t(53) = 2.36$, $p = .022$, $d = 0.67$. Figure C1 illustrates scores on the trait measures that were found to

significantly differ based on whether participants engaged in extra-experimental media multitasking or never multitasked during the study.

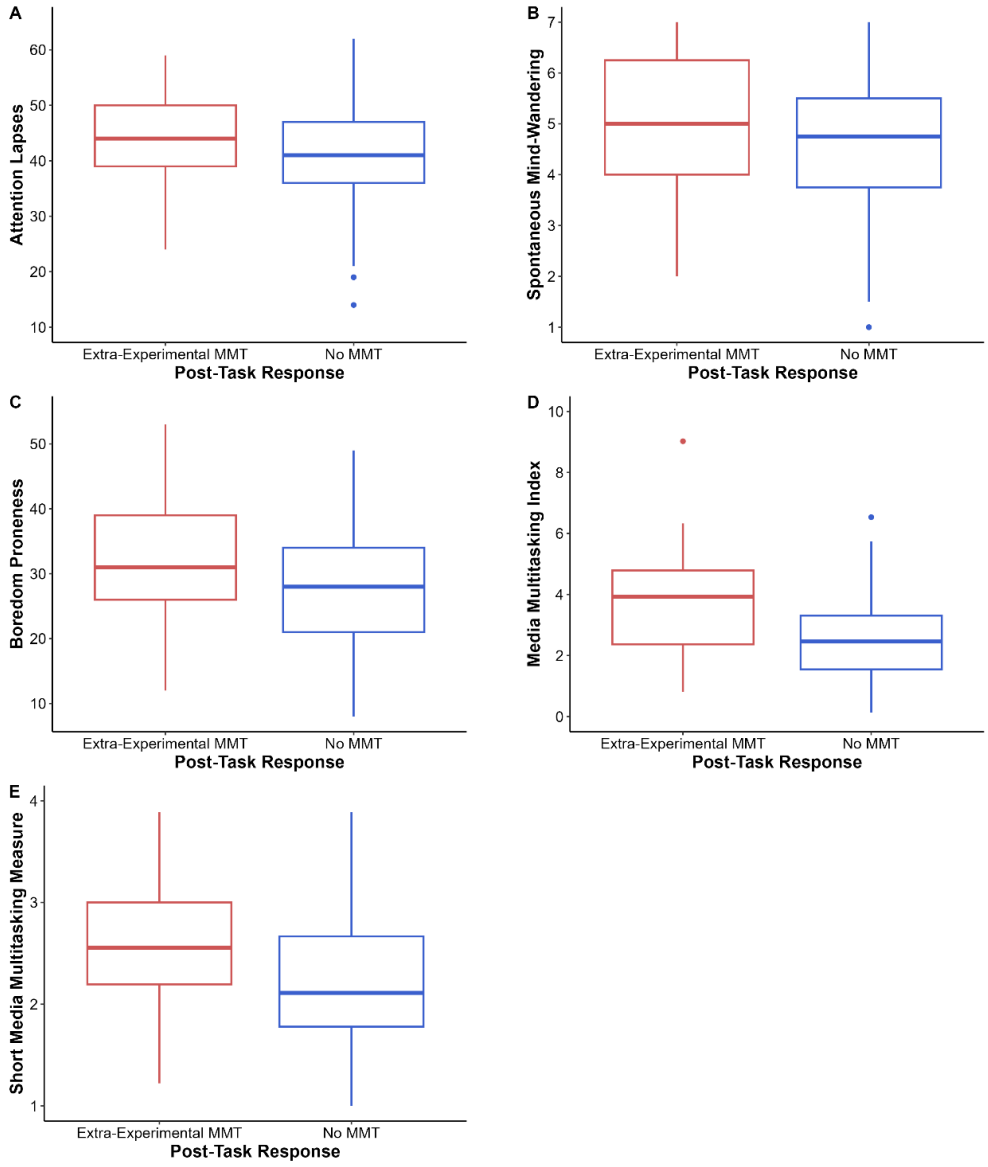


Figure C1. Boxplots depicting scores on individual difference factors as a function of whether participants engaged in extra-experimental media multitasking or refrained from multitasking of any kind. The *Extra-Experimental MMT* group consists of participants who engaged in media-related activities outside the experimental context, while the No M*MT* group consists of participants who refrained from engaging in activities outside the experimental context and never engaged with the optional video provided during the 1-back task. Plots are only shown for measures that significantly differed between groups (*ps* < .05).

Appendix D

Additional Analyses for Chapter 5

Table D1.

Correlations Between Individual Difference Measures

	Attention-related cognitive errors	Attention lapses	Spontaneous mind-wandering	Deliberate mind-wandering	Conscientiousness	Self-control	Boredom proneness	Media Multitasking Index
Attention lapses	.54***							
	(166)							
Spontaneous mind-wandering	.48***	.40***						
	(166)	(168)						
Deliberate mind-wandering	.21**	.09	.49***					
	(166)	(168)	(176)					
Conscientiousness	-.24**	-.23**	-.33***	-.14				
	(157)	(158)	(164)	(164)				
Self-control	-.49***	-.44***	-.53***	-.25***	.61***			
	(162)	(164)	(169)	(169)	(157)			
Boredom proneness	.49***	.55***	.39***	.20*	-.33***	-.57***		
	(160)	(162)	(170)	(170)	(158)	(163)		
Media Multitasking	.44***	.26*	.08	.05	-.28*	-.24	.23	
Index	(65)	(65)	(70)	(70)	(66)	(66)	(67)	
Short Media	.39***	.34***	.13	.06	-.11	-.21**	.26**	.61***
Multitasking Measure	(162)	(164)	(171)	(171)	(159)	(164)	(165)	(67)

Note. Scores on each of the individual difference measures were averaged prior to conducting the correlations. Numbers within the parentheses represent the sample for each relation, as participants did not consistently provide complete responses on all measures. * $p < .05$, ** $p < .01$, *** $p < .001$.