Recreational e-Reading Behaviour in Adults' Everyday Life

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It is what you read when you don't have to that determines what you will be when you can't help it.

- Oscar Wilde

Abstract

Frequent recreational reading of fiction is associated with various positive life outcomes, a strong reading ability, and a high socio-economic status. Despite of its importance, few adults read for pleasure in their free time, most often due to lack of time. To support adults in reading more often, we need information on how individuals read, especially on electronic platforms.

Most of previous work has relied on self-reports and lab-based approaches to understand variance in reading behaviour. However, these methods are biased by errors in retrospective recall and low ecological validity, and as a result, we know little about how adults read in the context of their daily lives. In this thesis, we address this research gap by tracking adults' natural e-reading behaviour unobtrusively on their own digital devices outside of the lab. We make use of two novel methodologies that allow us to capture participants' reading frequency, persistence in reading a narrative text, frequency of task-switching, and variation in text navigation patterns. These methodologies make it possible to study objective reading behaviour without compromising ecological validity.

Previous studies have connected self-reported reading behaviour to readers' motivation, experience with the electronic reading format, and the context in which a text is read. Across three experimental studies, we evaluate how (1) reader characteristics, such as reading motivation and electronic reading experience, and (2) task-contexts, such as location in text and timing of reading sessions, are connected to observed reading behaviour.

Together the studies provide a comprehensive view on reading behaviour during reading of narrative, electronic long-form texts on a variety of different devices. For the first two studies, we designed and developed a bespoke e-reader web application that participants could access from their own digital devices, such as smartphones and tablets. Embedded tracking features in the e-reader were used to track reading behaviour on the page-level. The first two studies provide rich descriptions of sixty and 729 adults' natural e-reading behaviour during reading of a short story and a full-length novel, respectively. In the third and final study, we compiled a dataset of reading behaviour from participants' Amazon Kindle user data. This approach made it possible for us to assess behaviour across multiple years, from many different texts, and on devices that could not be used to access the e-reader web application. In all studies, we collected information on reading motivation and experience with electronic reading platforms using questionnaires.

Across the three studies, our findings suggest that electronic reading behaviour is highly variable. Participants returned to the text multiple times a week; however, disengagements were common and continuous engagements were only 10-15 minutes long. Reading sessions were found to last between 1 minute and 6 hours in duration, and despite of the transportability offered by electronic texts, 78% of them occurred at home. Books and short stories were not read chronologically from the beginning to the end, but instead, 11% of navigation was nonlinear, either backwards in the text or forwards beyond the next page.

Variance in reading behaviour was connected to reader characteristics and task-contexts. The findings showed that avid readers with more contextual motivation towards reading as an activity returned to their selected book more often, they task-switched less frequently, and they adjusted their reading speed more adaptively in relation to text difficulty. Furthermore, situational motivation towards a specific text was associated with higher reading persistence in the second study, and more frequent reading sessions in the third study. The role of electronic reading experience was less conclusive, as the findings differed between the studies: during short story reading, task-relevant experience was connected to text navigation patterns, whereas in the second study participants with more experience of reading task-relevant texts were less likely to persist in reading their selected book. Findings on task-contexts, on the other hand, showed that readers adjusted their reading speed in relation to their location in text, and they task-switched more frequently while reading outside of the home and while reading on general-purpose devices, such as a smartphone or a laptop, instead of a dedicated e-ink e-reader.

This thesis provides much needed insight into adults' natural reading behaviour on digital devices. The findings challenge common preconceptions that fiction reading is a homogenous or a chronological activity, suggesting that adults read flexibly in the context of their daily lives. Our novel methodologies provide a middle-ground between self-report studies and lab-based experiments, enhancing our understanding of natural, electronic reading behaviour and its connection to reader characteristics and task-contexts. The results can be used to inform development of effective reading promotions to increase adults' reading engagement.

Lay Summary

When and where do adults read for pleasure? For how long at a time? Answers to these questions might be helpful in finding ways for more adults to incorporate recreational reading into their busy everyday lives.

Many adults struggle to find the time to read a book while juggling their everyday responsibilities. Although the benefits of reading for pleasure have been well established (see for example Mol and Bus, 2011 for a review), the development of effective practices to promote reading has been stalled by our limited understanding of how adults fit reading in their schedule.

Studying natural reading behaviour is tricky because of the limited availability of methodologies, and the changing nature of reading. Technology has revolutionised our reading habits, and 30 per cent of adults in the UK and US now read e-books for leisure on a dedicated e-reader, smartphone, tablet or a laptop (Faverio & Perrin, 2022; Nielsen, 2016). Reading behaviour is likely to be different between print and e-books as the two formats provide different ways of using them: whereas print books allow us to manipulate pages, for example, by dog-earing corners or by bending the page to view another simultaneously, electronic devices lack the same materiality; e-books, meanwhile, are fluid, with chapters ebbing and flowing between page turns, and text navigation requiring different techniques to print books.

These differences have led some researchers to suggest that digital devices do not support engaged reading. For example, Mangen (2008) argues that the intangibility of electronic texts makes reading more distractible, making it difficult for the reader to become immersed in the story. However, the root of the problem may not be the characteristics of e-books, but our lack of experience in reading them. Most adults have spent hours upon hours in front of a screen, but only a few are experienced in reading electronically for extended periods of time. Instead, we tend to e-read in short sprints, taking in only a couple of sentences before becoming distracted by notifications, or other online content (Liu, 2021). When we are familiar with using our digital devices in this way, these behaviours can creep into tasks that require focus, such as reading (Baron, 2017). Supporting adults in gaining task-relevant experience of reading long-form texts electronically could allow readers to access the potential of e-books: a wide variety of books are available online, the transportability of e-books allow individuals to read wherever they go, and the ability to adjust reading layouts can make reading more widely accessible.

In this thesis, I seek to understand adults' fiction reading behaviour on digital devices. Across three studies, adults' reading behaviour was observed with two innovative methods. First, we created an online e-reader that is similar to popular applications such as Amazon Kindle or Apple Books. The e-reader has embedded tracking functions which allowed us to observe the ways in which adults read e-books on their own devices. In two studies, sixty and 729 adults' reading behaviour was tracked during reading of a short story and a full-length novel, respectively. Our second method allowed us to assess reading behaviour on devices that could not be used to access the online e-reader, such as dedicated e-ink e-readers. We gathered a dataset from 31 adults' user data on Amazon Kindle devices and applications to assess reading behaviour across multiple different texts and devices.

Findings showed that most adults return to their e-book every three days for 30-45 minutes at a time. The reading sessions were not distraction-free, however, as most participants focused continuously on the text for only 10-15 minutes. The participants read in a variety of locations, ranging from work and transport to restaurants, although reading in the comfort of one's home proved to be most popular, despite one of the biggest selling points of e-books being their transportability.

Moreover, motivation and task-relevant experience were found to play a role in reading behaviour. Generally motivated avid readers returned to their selected book more often, they task-switched less frequently, and they read difficult texts more slowly and carefully, whereas less motivated readers raced ahead despite of their difficulty comprehending the text. Participants who were motivated to read a particular text were more likely to read it further and return to it more frequently. Findings on the role of electronic reading experience were less conclusive: in the first study participants with experience of reading electronically navigated the text more chronologically compared to those who were new to e-reading, whereas in the second study readers who were familiar with e-books were less likely to continue reading their selected novel.

In addition to these reader characteristics, reading behaviour was connected to the context of the reading activity. Our findings suggested that reading the beginning versus the end of a book or a short story is connected to different behaviour: participants used frequent nonlinear navigation, a slow reading speed, and disengaged from the text often at the beginning of the text, whereas towards the end, their pace picked up and they could focus on the text for longer periods of time. Furthermore, participants who were reading outside of their home and on general-purpose devices, such as a smartphone or a laptop, were found to task-switch more often compared to those who were reading on a dedicated e-ink e-reader in the comfort of their home.

Reading behaviour research is only in its infancy, but it has great potential to support future promotions to encourage reading for pleasure. Our findings showcase that adults vary in the ways in which they read e-books. This variance, and its connection to motivation, task-relevant experience, and task-contexts, could explain why some manage to get through dozens of books a year, whereas others struggle to find the time to read.

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Only when starting to write the acknowledgements did I realise how many people have supported and helped me through the journey of this PhD. Seeing this wild project come true has been a source of more happiness and excitement than I can describe. As an avid reader, getting to see a glimpse into the world of how others read has been a delight. However, a PhD is a lot of work and I would have never made it through it without all the people who cheered me on.

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Declaration

I declare that this thesis was composed by myself, that the work contained herein is my own except where explicitly stated otherwise in the text, and that this work has not been submitted for any other degree or professional qualification except as specified.

(Pauliina Tea Eleonoora Vuorinen)

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Chapter 1

Introduction

1.1 Importance of Recreational Reading of Long-form Fiction

From bus timetables to legal contracts, text is everywhere around us. The ability to comprehend this information is essential for becoming an independent and active part of the society. Although 99% of adults in Western countries have the ability to read (Roser & Ortiz-Ospina, 2016), many struggle with the literacy demands that they face in their everyday lives. A study on global literacy levels by OECD (2016) showed that an average adult's limited reading ability can make it difficult for them to understand lengthy or dense texts, such as newspaper articles or medical instructions. Furthermore, 19% of adults have been found to have poor literacy skills which is likely to affect their employment prospects and risk their financial independence (OECD, 2016; Teravainen-Goff et al., 2022). Indeed, a low reading ability has been associated with a variety of negative outcomes, such as poor physical and mental well-being, limited social connections, and lower life expectancy (Teravainen-Goff et al., 2022). Accordingly, enhancing adults' literacy level has been identified as an important societal goal to improve overall quality of life (Hilhorst et al., 2018).

Reading is an effortful activity which requires considerable control over working memory, the ability to make inferences from text, and an understanding of various rhetorical means of language (Kintsch & van Djik, 1978; McVay & Kane, 2012). Reading is not an innate or instinctive process, and becoming efficient in decoding text requires considerable effort from the reader (Rapp et al., 2007; Wolf & Barzillai, 2009). Reading skills develop over time with practice, and so frequent reading engagement makes us faster and more accurate at processing text (Stanovich, 1986). As decoding becomes an automatic process, the reader can focus on comprehending the meaning in a text (Pikulski & Chard, 2005). Comprehending text requires both extensive vocabulary and higher-order cognitive skills, such as comparing the information in a text with background knowledge (Boerma et al., 2017). Both skills develop slowly across our life spans through exposure to language (Boerma et al., 2017). Speech and conversational texts enhance our vocabulary and language ability, however, they do not prepare us to comprehend texts that make use of varied and uncommon phrases: conversations generally make use of only the most common words in a language, whereas written texts frequently include technical and low-frequency phrases (Gardner, 2004; Hayes & Ahrens, 1988). As a result, exposure to varied vocabulary via written texts is essential for improving comprehension skills. Indeed, previous research has shown a robust link between a strong reading ability and frequent reading engagement (R. C. Anderson et al., 1986; Pfost et al., 2013; Stanovich, 1986).

To regularly engage in an effortful activity like reading, the reader needs to be motivated (De Naeghel et al., 2012). Avid readers are intrinsically motivated and so they engage in reading simply because they enjoy it as an activity (Deci & Ryan, 2000; Schiefele et al., 2012). They read more frequently and more in volume than their extrinsically motivated peers who engage in reading for instrumental purposes, for example, to avoid a punishment or to attain a reward (Schiefele et al., 2012). Whereas extrinsically motivated readers only pick up a book when they are faced with external pressure to do so, intrinsic motivation drives readers to read in their leisure time (Schiefele et al., 2012). As a result, intrinsic motivation to read has been connected to a strong reading ability, whereas no association has been made between extrinsic motivation and reading skills (Schiefele et al., 2012).

In particular, recreational reading of narrative, long-form fiction, such as books or short stories, has been found to be important for a strong reading skill (Torppa et al., 2020). Findings from Spear-Swerling et al. (2010) and McGeown et al. (2015) showed that children with a high reading competence read fictional books and short stories in their free time more often than their peers. Similarly, adults' fiction reading frequency has been positively associated with comprehension and verbal ability (Acheson et al., 2008; Mar & Rain, 2015). Martin-Chang et al. (2020) suggest that this connection between narrative fiction and reading competence may reflect the readers' motivation: intrinsically motivated readers tend to reach for highly enjoyable texts that require little effort to read, such as novels and short stories with an engaging storyline (Gardner, 2004; Nell, 1988b; Smith, 2000; Spear-Swerling et al., 2010). These texts support the reader's motivation and encourage them to read them frequently (Gilson et al., 2018). In contrast, expository texts are denser and more complex than narrative fiction (Gardner, 2004) which makes individuals less likely to read them for extended periods of time or to return to them frequently. Indeed, no connection has been made between frequency of reading expository texts, such as nonfiction books or newspaper articles, and reading ability (Acheson et al., 2008; Mar & Rain, 2015).

1.2 Reading Behaviour

Despite of the importance of reading, 36% of adults and 44% of young adults do not read for pleasure (Department for Culture, Media, & Sport, 2015). Findings by Gallik (1999) showed that 48% of college students read less than two hours a week recreationally, and most of this time is devoted to reading newspapers, magazines or online articles, which have not been connected to the positive outcomes of reading (Pfost et al., 2013). In the US, findings by Gelles-Watnick and Perrin (2021) showed that 23% of adults had not read a book in full or in part within the past 12 months, and on average, adults reported reading only 4 or 5 books a year. In contrast, avid readers have been found to read dozens of books every year (Kaiser & Quandt, 2016).

Adults tend to be aware of the importance of reading, with 78% of adults in the UK agreeing that “people with good reading skills have more opportunities to do well in life” (Teravainen-Goff et al., 2022). However, many are reluctant to read due to low motivation or limited reading competence (Applegate & Applegate, 2004; Gallik, 1999; Martin-Chang et al., 2020). Findings by Teravainen-Goff et al. (2022) showed that 16% of the survey respondents indicated that they avoid tasks that involve reading, whereas 29% reported that they give up reading difficult texts. Similarly, interviewees in a study by Rosenthal (1995) reported that they find reading unpleasant and effortful, and so they avoid it, and 55% of non-readers in a study by Quick Reads and Billington (2015) indicated that they do not enjoy reading. Many of these ‘reluctant readers’ reported that their low motivation stems from negative past experiences with reading (Applegate & Applegate, 2004; Martin-Chang et al., 2020; Quick Reads & Billington, 2015).

In addition to these barriers, individuals’ circumstances can prevent them from engaging in reading (Martin-Chang et al., 2020). Findings by Quick Reads and Billington (2015) showed that 42% of infrequent readers in the UK struggle to find the time for reading. In a follow-up interview, adults reported that they find it difficult to prioritise reading among their multiple daily responsibilities, such as childcare and work. A similar finding was reported by Applegate and Applegate (2004) which showed that across two studies 28% and 35% of adults could be categorised as ‘lukewarm readers’ because of their high motivation to read and low reading frequency. Indeed, adults juggle a variety of responsibilities in their everyday lives which can leave little time and energy for an effortful activity such as reading.

To address barriers to reading, it is important to understand reading engagement and motivation within the context of adults' daily lives. Readers differ not only in how frequently they engage in reading, but for how long, in what conditions they read, and how they navigate a text (Everatt et al., 1998; Merga, 2017b). Understanding this *reading behaviour* is essential for supporting adults in increasing their reading engagement.

To support adults in incorporating reading into their busy everyday lives, it is important to consider the conditions in which they read and how reading behaviour varies in relation to these constraints. For example, reading behaviour is likely to be influenced by reading location, the timing of reading sessions, and how far in the text the reader is. Reading during a commute can result in short reading sessions and frequent distractions, whereas reading in a quiet, distraction-free environment may support engagement for longer periods (Kosch et al., 2021; Merga, 2017b). Likewise, location in text and timing of reading sessions can affect reading behaviour: different sections of a text are likely to vary in how engaging they are to the reader (Merga, 2017b; Syd Field, 2005), and long reading sessions may cause the reader to slow down their reading speed if they become fatigued. These *task-contexts* of reading behaviour can be used to explain why some adults struggle to find the time for reading while others can get through multiple books a year.

Furthermore, reading behaviour is connected to the reading format. More than 30% of adults in the US now use digital devices for reading (Faverio & Perrin, 2022), and 20% of adults in the UK prefer digital reading over print (Gloag & Lockey, 2019). A Nielsen consumer report shows that nearly half of all adult fiction is bought electronically as 'e-books' (The Nielsen Company, 2021). The majority of adults read electronically on their tablet computers or mobile devices, but approximately 19% also own a dedicated e-reader device (M. Anderson, 2015). While only a minority of readers rely on digital devices entirely, increasing amounts of readers use both digital reading devices and print books in their everyday life (Kuzmičová et al., 2020; Maloney, 2015). Many prefer to use multiple devices for reading and changing these devices between sessions (Kuzmičová et al., 2020).

Electronic reading platforms provide different affordances than printed paper books, which is likely to have an impact on reading behaviour. Printed material provides the reader with constant haptic feedback and so the reader can manipulate the page, for example by dog-earing corners or by bending the page to view another simultaneously. In contrast, electronic texts lack the same materiality: ebooks are fluid, with chapters ebbing and flowing between page turns, and navigation requiring different techniques to print books (Bansal, 2011). Furthermore, different devices provide different affordances which can influence reading behaviour. For example, competing applications and notifications can make reading more distractible on general-purpose devices, such as smartphones and PCs, whereas dedicated e-ink e-readers provide few affordances beyond reading and so they can support extended reading engagement (Kosch et al., 2021).

These differences have been argued to make electronic reading more shallow and distractible than print reading (Delgado & Salmerón, 2021; Mangen, 2008). Indeed, 92% of respondents in a study by Baron et al. (2017) indicated that they find it easier to concentrate when reading print texts. However, electronically experienced readers who are familiar with these reading platforms may not be equally affected (Yoo & Roh, 2019). They tend to be skilled in navigating electronic environments, and they can ignore distracting elements, such as notifications, while reading electronic texts (Yoo & Roh, 2019). As a result, electronically experienced readers are likely to read digital texts differently from their inexperienced peers.

In fact, *reader characteristics* such as motivation and electronic experience are likely to influence the ways in which adults read electronically. Previous research has connected intrinsic motivation and electronic reading experience to a higher reading frequency and persistence (Levine et al., 2022; Yoo & Roh, 2019), fewer disengagements from the text (Ralph et al., 2021; Tulis & Fulmer, 2013), and more attuned reactions to text difficulty (Worthy et al., 2001).

Studying how adults read electronically and how reading motivation and experience with electronic texts influence reading behaviour can be used to support adults in unlocking the positive potential of reading on digital devices. A wide variety of books can be made available online, whereas print collections are limited by storage facilities (Torres et al., 2014). 92% of adults in the UK and 85% in the US now own a smartphone (Atske & Perrin, 2021; Lee & Stanton, 2022), and therefore, they can bring ebooks with them wherever they go. Furthermore, the ability to adjust reading layouts electronically can make reading more widely accessible for readers with visual disorders, and the varied construction of electronic devices can make them easier to hold for individuals who have difficulty with print texts (Woodward, 2014).

1.3 Research Gap and Our Approach

Understanding adults' reading behaviour is key to increasing their reading engagement. However, we currently know little about the ways in which adults fit reading in their daily lives. Past research has focused on children's reading engagement, and only a few studies have explored adults' reading behaviour (Schiefele et al., 2012). Although children's motives have been found to be somewhat similar to the motivation behind adults' reading engagement (Schutte & Malouff, 2007), the conditions of reading are different for adults and children. Reading for leisure becomes an increasingly independent and voluntary activity towards adulthood. Whereas children are often encouraged to read for pleasure (Wilkinson et al., 2020), adults need to find the time for reading among their multiple responsibilities if they wish to do so. As a result, findings on children's reading behaviour may not generalise to adult populations.

Furthermore, studying natural reading behaviour is difficult due to the limited availability of methodologies. Previous research has been limited to self-reported and lab-based measures of reading behaviour. Interviews and questionnaires have provided valuable information on individuals' reading experience, however, the findings may be distorted by errors in retrospective recall and by tendencies to report socially desirable behaviour (Smith & Stahl, 1999; West et al., 1993). Diary and experience-sampling methods have attempted to address this issue by asking participants to report their reading behaviour multiple times a day, often in response to a notification (e.g., Foasberg, 2014). However, these methods may disrupt the reading activity, and participants may be motivated to engage in more frequent reading than usual if the probes function as reminders to read. Furthermore, it is unclear whether individuals are aware of their own reading behaviour and the amount of time they spend reading (S. White et al., 2010). Indeed, previous research on meta-awareness has illustrated that individuals are often unaware of the contents of their experiences (Schooler, 2002).

Objective methodologies are needed to complement findings from qualitative studies. Lab-based approaches, such as eye-tracking experiments, have been used to study reading behaviour in a controlled setting. Indeed, eye-tracking research has provided an important foundation for our understanding of low-level reading behaviour: participants' eye movements can be observed to study how individual words and sentences are read (Jarodzka & Brand-Gruwel, 2017). However, eye-tracking studies are usually limited to reading short texts, and it is unclear to what extent the results can be generalised to much longer texts, such as short stories or full-length novels (Jarodzka & Brand-Gruwel, 2017). Furthermore, these experiments include a highly controlled setting which can distort the participants' natural behaviour: individuals act differently when they are in an unfamiliar environment or situation, such as the lab, which is unlikely to reflect their natural behaviour (Kingstone et al., 2008). To establish a valid understanding of reading behaviour, it is important to study reading within an *ecologically valid* context which reflects the circumstances in which reading naturally occurs (Kingstone et al., 2008; Tatler & Land, 2015). Due to limited methodologies, however, few studies have been conducted using objective methodologies outside of the lab. In this thesis, we address this gap by using novel methodologies to track reading behaviour. Observation is conducted unobtrusively using participants' own digital devices to study reading within an ecologically valid setting.

Previous research has used inconsistent definitions for 'reading', 'engagement', and 'reading behaviour'. We define 'reading' as the activity of processing written text by moving eyes across words. In common language, 'reading' is occasionally used to refer to a wide variety of activities, such as audiobook listening or braille reading. These alternative ways of representing and processing text are important for the accessibility of reading, and they have been connected to similar experiences and processes as visual reading of text (Daneman, 1988; Lange et al., 2022). Furthermore, the definition of 'reading' can vary in relation to the presentation of the text. For example, in rapid serial visual presentation, the reader is presented one word at a time in a focal point, to eliminate eye movements (Rayner et al., 2016; Schotter et al., 2014). To limit the scope of this thesis, 'reading' is used to refer to the activity of processing text visually when static text is presented in sentences, paragraphs, or pages.

Previously, 'reading behaviour' has been used non-specifically to describe habits and cognitive processes associated with reading. We define reading behaviour as behaviour that can be observed or measured quantitatively, such as for how long or how linearly a text is read. In particular, we focus on five measures of behaviour - reading frequency, persistence, task-switching frequency, linearity, and speed of reading - which have been discussed in previous research. These measures allow us to assess behaviour comprehensively in adults' everyday life.

Reading behaviour is studied during reading of electronic texts such as books and short stories which have been previously described as ‘traditional’ or ‘linear’ (e.g., Jang et al., 2021; Singer & Alexander, 2017). These texts are similar to their print equivalents, and they are often read in a dedicated reading environment, such as an e-reader application or an e-reader device. In contrast, ‘web reading’ encompasses reading of digital texts such as websites, online news articles, and social media posts. Web reading is characterised by different affordances to ‘linear’ digital texts: they often include hyperlinks that allow readers to rapidly navigate to alternative materials, and the pages frequently contain competing information, such as adverts or videos, that are intended to compete for the reader’s attention (Hillesund, 2010). Considering the role of narrative long-form fiction in reading competence, we focus on behaviour during reading of ‘linear’ electronic books and short stories without comparison to other formats, such as web reading or print reading.

Throughout this thesis, we use ‘reading engagement’ to describe behavioural involvement in reading[1]. We expect participants to be engaged in reading when they are viewing a text, and so we can assess reading engagement by observation. As a result, we assess reading engagement as a behavioural event rather than a psychological state or a persistent trait of a reader (see e.g., Lee et al., 2021 for more information on other interpretations of reading engagement). In contrast, ‘disengagement’ is used to describe the act of moving away from reading, for example by switching to an alternative task.

In line with our definition, most previous research has focused on the behavioural dimension of reading engagement (Lee et al., 2021). However, reading engagement is a multifaceted concept that relates not only to the reader’s behavioural engagement with the text, but their affective, cognitive, and social involvement with it (Lee et al., 2021). The affective dimension describes readers’ emotional involvement by empathising with the story characters and becoming immersed in a narrative (McGeown & Conradi Smith, 2024). Cognitive engagement, on the other hand, describes the cognitive effort the reader puts in the reading task, and social engagement indicates that the reader shares the reading activity with others, for example by recommending books or taking part in book club (McGeown & Conradi Smith, 2024). Engagement in reading across all four dimensions has been connected to various positive outcomes (e.g., Clark & Teräväinen-Goff, 2018; Torppa et al., 2020). To

[1] The use of the word ‘involvement’ in the definition is similar to that of Cambridge Dictionary (n.d.) who refer to ‘engagement’ as ‘the fact of being involved with something’

limit the scope of this thesis, however, we focus on the behavioural aspect of reading engagement that can be observed by objective measurement of reading behaviour.

1.4 Our Aims

This thesis aims to enhance our understanding of how adults read narrative texts on digital devices within the context of their everyday lives. Across three studies, information on reading behaviour was gathered from short story reading (Chapter 4), book reading (Chapter 5), and multiple text reading (Chapter 6). The first two studies (Chapter 4 and 5) make use of a bespoke e-reader web application which is explored in detail in Chapter 3, whereas multiple text reading was studied using third-party user data obtained from participants' Amazon Kindle devices in Chapter 6.

Across the three studies, we explore two research questions:

RQ1: Is electronic reading behaviour connected to the readers' motivation and electronic reading experience? How?

RQ2: Is electronic reading behaviour connected to the task-context? How?

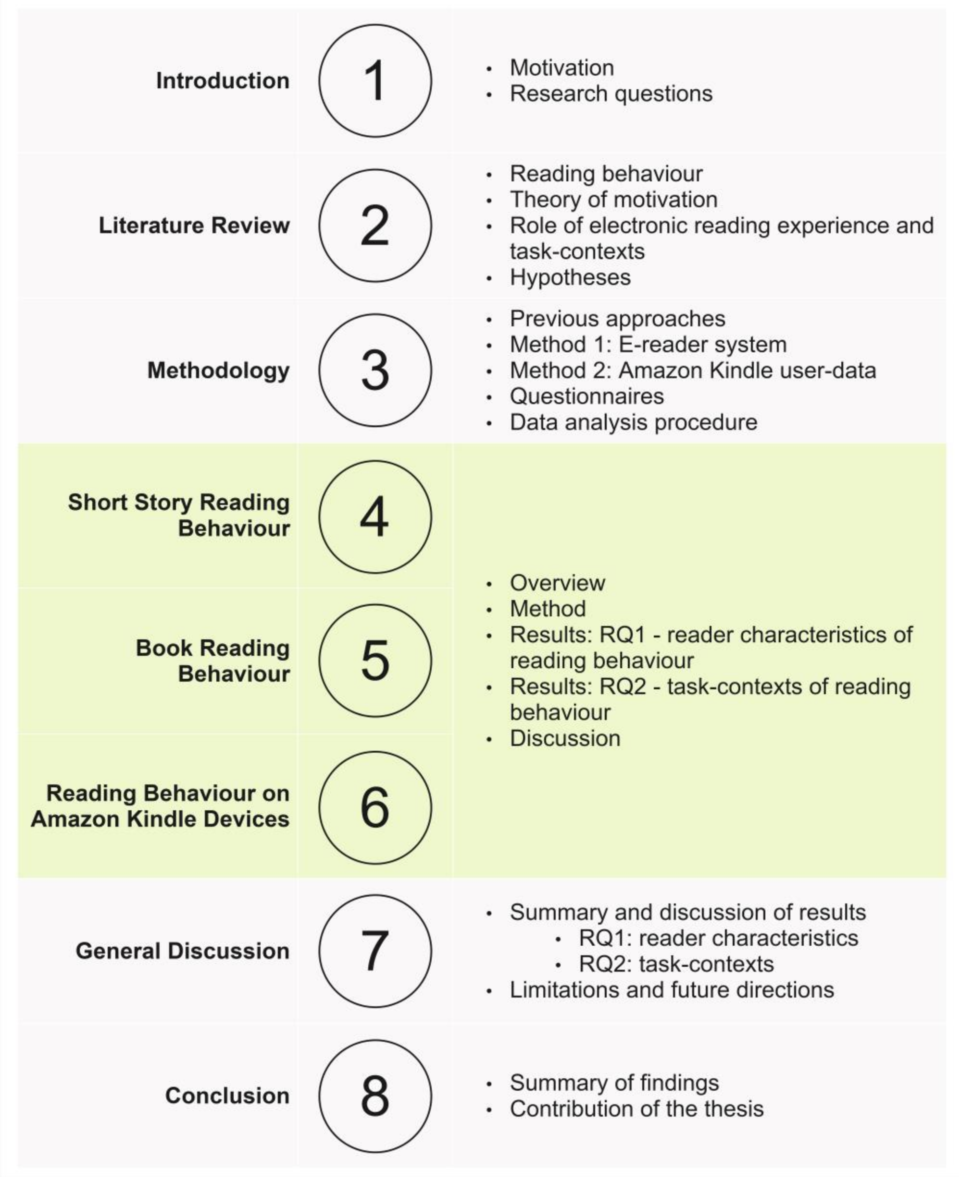
Enhancing our understanding of these task-contexts and reader characteristics of reading behaviour will provide a foundation for development of interventions that can be used to support adults' reading engagement.

1.5 Chapter Preview

This thesis is organised in eight separate chapters. See Figure 1.1 for an illustration of the thesis structure.

Figure 1.1

Chapter Structure of the Thesis



Note. The chapters highlighted in green reflect the experimental chapters in this thesis.

In *Chapter 2*, we explore previous research on reading behaviour and motivation. We review previous measures of reading behaviour, and how task-contexts, such as location in text, can affect behaviour. To establish our position on reading motivation, we review motivation theories and the influence of motivation on reading behaviour. Furthermore, we explore the influence of reading competence on motivation and behaviour, and the ways in which electronic reading experience may be connected to digital reading behaviour. Finally, we establish detailed research questions on the basis of the literature review, and set hypotheses.

Chapter 3 focuses on methodologies in reading behaviour. We briefly review previous approaches to studying reading, and then describe two different methodologies used in this research project. Furthermore, we describe the strengths and limitations of each method, and explain our usage of questionnaires to measure motivation and electronic reading experience. Finally, we outline our approach to the analysis of reading behaviour by multilevel models.

Chapters 4-6 describe three different studies on adults' recreational reading behaviour. In *Chapter 4*, we report a study in which 60 participants were tracked during reading of a short story on an e-reader web application. The following study, presented in *Chapter 5*, expands this approach by tracking reading behaviour during reading of a full-length novel using a larger sample (n = 729). Finally, *Chapter 6* describes 31 participants' e-reading behaviour across multiple different texts on dedicated e-reader devices by making use of a third-party dataset from Amazon Kindle.

The final two chapters, *Chapter 7* and *Chapter 8,* are used to summarise and then discuss the findings and tie them with previous research. Chapter 7 includes a discussion of future directions, and Chapter 8 concludes this thesis by highlighting our contributions.

1.6 Publications

Some of the work described in this thesis has been published or presented in conferences. An early version of the e-reader system was showcased in a poster and a presentation in IGEL reading conference 2020, whereas partial results from the second study (Chapter 5) were presented in the 22nd Conference of the European Society for Cognitive Psychology in 2022. An earlier version of the lay summary was published as part of a special issue blog post on British Educational Research Association's (BERA) website: https://www.bera.ac.uk/blog/how-do-adults-read-ebooks-exploring-the-connection-to-motivation-and-experience-with-e-reading. Work described in Chapter 4 was published in Frontiers in Education in January 2024[2], and journal manuscripts are in preparation on the e-reader system, and on the studies described in Chapter 5 and Chapter 6.

[2] See Vuorinen, P. T. E., Tatler, B. W., & Keller, F. (2024). Tracking e-reading behavior: uncovering the effects of task context, electronic experience, and motivation. *Frontiers in Education, 8*(1302701). doi: 10.3389/feduc.2023.1302701

Chapter 2

Background

2.1 Overview

To support adults in incorporating more recreational reading in their everyday lives, it is important to understand their reading behaviour. In this chapter, we review previous research on reading behaviour, and its connection to the reader and the conditions in which they read. ‘Reader characteristics’ is used to refer to the individual’s characteristics, such as demographics, motivation, and electronic reading experience, which can influence the ways in which narrative texts are read. Similarly, ‘task-context’ can influence behaviour. It is used to describe the reader’s environment and the characteristics of the text being read.

First, we discuss the ways in which individuals have been found to read narrative texts. Behaviour is discussed in relation to reading engagement, what causes disengagements from reading, and how readers navigate texts. Second, previous research is reviewed on the relationship between reader characteristics and reading behaviour. Particular focus is put on the effect of reading motivation and electronic reading experience. To situate this thesis within theoretical research on motivation, we review common reading motivation theories and discuss how they conceptualise motivation and its effect on behaviour. We adopt the Self-determination theory by Deci and Ryan (1985) with the extension of the Hierarchical Model of Motivation by Vallerand (2000) as the theoretical framework of reading motivation in this thesis. The basis of electronic reading experience, on the other hand, is established on the basis of the Technology Acceptance Model by Davis (1989). Third, reading behaviour is discussed in relation to the task-contexts of reading. We review the effect of text characteristics, and circumstances of reading, such as reading location and the timing of reading sessions. Finally, we expand the research questions set in the Introduction, and establish hypotheses on the ways in which reading behaviour is connected to reader characteristics and task-contexts.

2.2 How Do We Read Books?

Reading is often thought to be a homogenous, stilted, and lonely activity (Hillesund, 2010). However, in reality, readers vary in *how* they read. Reading can be an independent activity or something shared with others, for example via book discussions, recommendations, or reviews (Rebora et al., 2021; Sylvan, 2018). Furthermore, readers vary in how they select books to read (Cavazos-Kottke, 2006), and how they progress through a book (Milne, 2021).

2.2.1 Engagement in Reading

The majority of previous research has relied on measures of *reading frequency* and *reading amount* to assess behaviour. Whereas the former describes how often individuals engage in reading, either in general or in relation to a specific text, reading amount is used to assess, for example, how many books adults read a year or for how long they engage in reading within a week.

On average, adults have been found to read in their leisure time once a week (GfK, 2017; Ibbetson, 2020), and they can get through 4-5 books in a year (Faverio & Perrin, 2022). Variation from this norm has been used to categorise individuals into avid or infrequent readers. Whereas avid readers read frequently and in high volume, infrequent readers may avoid reading or struggle to find time for it (Woodlet & Mantell, 2020). According to a global study by GfK (2017), 22% of adults could be described as infrequent readers as they read less than once a month or never, whereas a large-scale study in the UK found that 36% of adults were infrequent readers who had not read for pleasure within the past year. These reluctant readers have the skills to read, but they choose not to do so (Brinda, 2011). For example, a reluctant reader in a study by Juel (1994) reported that "I would rather clean the mold around the bathtub than read" (p. 24). In contrast, avid readers have been found to read 3-14 hours a week (Nolan-Stinson, 2008; Quick Reads & Billington, 2015). The high reading frequency translates into large reading amounts, and indeed, avid readers have been reported to read 12-68 books a year (Kaiser & Quandt, 2016; Nell, 1988b; Sheldrick Ross, 1999)

Reading persistence can be used to describe how far in a text one reads, and whether a text is read to completion or not. Book reading is often expected to be chronological, and result in the book being finished. However, in reality, readers frequently stop reading books part of the way through. A questionnaire conducted by a book review site Goodreads indicated that 44% of readers abandon books before the 100-page mark, most often due to a slow or a boring plot (Goodreads, 2013). A report by Kobo, on the other hand, showed that readers finished only 40% of the books they had purchased for their dedicated e-reader devices (Woodlet & Mantell, 2020). Most often, literary fictions were left unfinished, whereas thrillers and romances were most likely to captivate the reader until the very end (Flood, 2014). Similarly, findings from a reader analytics tool intended for publishing research, ‘Jellybooks’, found that low reading persistence is common. A popular book in their service was finished by less than 30% of the readers who started it, and overall, only 5% of the electronic books offered for free by Jellybooks were read to completion by more than 75% of the readers (Alter & Russell, 2016). A high level of persistence, therefore, may not be the norm in book reading. This conclusion was also reached by Braslavski, Petras, et al. (2016) in analysis of reading logs from an online book subscription service. Their findings showed that only 36% of books that were started by users were read to completion. The users added many more books to their library than they finished, and only 1.3% of the readers had finished at least 90% of the books that they had saved.

Although low persistence is common, giving up on a book can be a difficult decision for the reader. A survey by The Reading Agency (2018) showed that 54% of adults in the UK “*spend up to 3 months struggling through a book before deciding to give up on it*”. A quarter of the respondents indicated that all books should be finished, and similarly, findings by Goodreads (2013) showed that 38% of readers “*always finish, no matter what*”. Readers can feel uneasy about leaving books unfinished, which can cause them to keep reading despite of low enjoyment (The Reading Agency, 2018).

2.2.2 Disengagement from Reading

Reading requires a considerable amount of focus from the reader. However, distractions are common, which can cause the reader’s attention to drift away from the text. *Task-switching* refers to the alternation between two or more tasks (Kononova et al., 2016), and for example, a reader may alternate between reading a book and checking social media. In contrast, *multitasking* describes concurrent engagement in two or more activities, such as reading while listening to music (Kononova et al., 2016).

Previous studies have indicated that task-switching and multitasking are common during effortful tasks such as reading (e.g., Chevet et al., 2022). Rosen et al. (2013) observed adolescents and young adults during a 15-minute study session and found that they task-switched on average every 5.6 minutes, and so they spent less than 10 minutes of the study session on-task. A study by Mokhtari et al. (2009), on the other hand, showed that 42% of readers multitask during reading by listening to music, cooking, exercising or eating. Individuals often report that they multitask and task-switch because they prefer it to solely reading a text (Rosen et al., 2013).

Both task-switching and multitasking have been argued to be detrimental for reading comprehension, especially when time is limited (Clinton-Lisell, 2021). Individuals have limited cognitive resources which constrains how much information can be processed at a time (Pashler & Johnston, 1998). Multitasking can stretch our attention thin, resulting in poor performance in both of the tasks (Pashler & Johnston, 1998). Similarly, frequent alternation between tasks during task-switching can strain our focus: as we move our attention from one activity to another, a part of our focus remains in the previous task, compromising performance in the latter task (Pashler et al., 2001).

Effortful tasks such as reading require the individual to hold multiple pieces of information in their working memory (Johann et al., 2020). Due to limited resources, this information may be lost during task-switching (Cho et al., 2015). Re-attending to the text may therefore require the reader to backtrack in the text to refamiliarise themselves with it, which can result in longer reading times (Bowman et al., 2010), and lower comprehension if the fragmented engagement undermines understanding of a complex text (Liu & Gu, 2020).

Task-switching and multitasking are often assumed to result in negative consequences for reading comprehension and engagement (Liu, 2022). However, task-switching and multitasking may also have a role in supporting readers' attention. Findings from Ariga and Lleras (2011) indicated that short, voluntary disengagements from an effortful task can act as breaks. These brief disengagements can reduce fatigue, and as a result, support reading for extended periods (Ariga & Lleras, 2011). Similarly, a study by Kononova et al. (2016) showed that task-switching does not always have a negative effect on comprehension. Their findings showed that participants with a high preference for multitasking had low text comprehension scores when they were forced to task-switch between reading a text and checking social media. However, no negative effect was found when the participants could engage in task-switching freely during the reading task. It is possible that the participants were able to use task-switching adaptively as a break in the voluntary task-switching condition, whereas forced task-switching acted as a distraction. Findings from interviews have echoed these results, as 39% of interviewees in a study by Liu (2022) reported that multitasking and task-switching help them avoid feeling bored during reading.

Although voluntary task-switching may not affect comprehension, it has been connected to longer reading times (Clinton-Lisell, 2021). Findings from a meta-analysis by Clinton-Lisell (2021) showed that task-switching was connected to significantly longer reading times than continuous focus on a text. The effect did not disappear after deducting the time spent task-switching from the overall duration, indicating that the act of task-switching slows down the act of reading (Clinton-Lisell, 2021). This may be due to the need to reread previous sections of text following a task-switching event, or an overall slower reading speed (Bowman et al., 2010).

In addition to task-switching and multitasking, readers can become distracted from the text by *mind-wandering*. During this mindless reading, the reader moves their eyes across the text without attending to it (Reichle et al., 2010). Instead of focusing on the text, the reader is immersed in task-unrelated thoughts (Randall et al., 2014). Reichle et al. (2010) used eye-tracking to observe mind-wandering while participants read Jane Austen's *Sense and Sensibility* in full. Their findings showed that participants self-reported mind-wandering during the study on average 22.5 times and they were caught doing so approximately 9% of the time without awareness, indicating that on average the readers mind-wandered every 23 minutes during reading of the novel. Mind-wandering episodes are usually triggered by internal distractions, such as fatigue or hunger (Soemer & Schiefele, 2019), but they can also occur if the text reminds the reader of unrelated thoughts (Rapp et al., 2007), if the text content is unstimulating (Faber et al., 2018), or if an external stimuli draws the reader's attention (Soemer & Schiefele, 2019).

Mind-wandering often occurs without the readers' intention or awareness (Soemer & Schiefele, 2019). As a result, mind-wandering can feel uncontrollable for many readers, and it may not be noticed for several minutes (Reichle et al., 2010). For example, one of the interviewees in a study by Rosenthal (1995) reported that "I daydream when I read. I'll start reading and all of a sudden I'm down to the bottom of the page, and I don't remember a thing I've read between here and there." (p. 39). Text processing is impaired during mind-wandering (Forrin et al., 2021), and therefore, it is plausible to expect that the reader needs to reread sections that they missed if they wish to comprehend the text in full. As a result, mind-wandering may result in lower reading speed and a higher incidence of nonlinear navigation.

2.2.3 Text Navigation

Individuals vary in the ways in which they navigate a text. Readers do not solely read texts chronologically from the beginning to end, but they alternate their *linearity of reading*. During reading, we direct our high acuity fovea at the target word and keep the eye still for periods of fixation, during which useful visual information is extracted (Rayner, 1998).

Saccades, rapid eye movements, are used to move the fovea to new words to fixate them (Rayner, 1998). Due to the high speed of saccades and central mechanisms that suppress vision during them, no new visual information can be obtained from saccades (Radach & Kennedy, 2004). Instead, information from a text is gathered with fixations (Rayner, 2009). Although the majority of words in a text are fixated, the processing of each word is not necessary for comprehending the text (Rayner, 2009). Indeed, readers use what we call *forward leaps* to skip through words in a text, and approximately only 85% of content words and 35% of function words are fixated (Rayner, 2009). Similarly, readers read texts nonlinearly by moving backwards in it by *regressions*, which comprise approximately 10-15% of all saccades in skilled readers (Rayner, 2009).

Regressions backward in text are often triggered by difficult texts and low comprehension (Vitu & McConkie, 2000). They are used to reread previous sections of a text that was not understood, or which requires further processing (Vitu & McConkie, 2000). Accordingly, a low reading skill and difficult texts are associated with a higher frequency of regressions (Rayner et al., 2016). Indeed, regressions have been found to be crucial for comprehension of a text: findings by Schotter et al. (2014) showed that elimination of nonlinear navigation during reading results in poor text comprehension. In the study, participants either read a text normally or each word was masked once the reader's eyes had moved past it, making regressions impossible. Eliminating regressions made it difficult for participants to comprehend the text, even when the content was unambiguous and easy to understand (Schotter et al., 2014). In contrast, forward leaps are used when the text is easy or predictable to read (Radach & Kennedy, 2004). Readers can skip past common or predictable words in a text, and still fully comprehend the content (Faber, Mak, et al., 2020; Radach & Kennedy, 2004; Rayner et al., 2016).

The majority of previous research has focused on sentence and paragraph level regressions and forward leaps during reading (Jarodzka & Brand-Gruwel, 2017). In contrast, higher level nonlinear navigation that spans multiple paragraphs or even pages, has been argued to be rare (Rayner, 1998; Weger & Inhoff, 2007). However, this may be due to the methodologies used to study linearity of reading. Previous research is focused on eye-tracking studies that are conducted within highly constrained experimental settings. The formal setting of these studies, along with the presence of the researcher, can encourage the participant to read the text more carefully than they would in a natural environment (Faber, Krasich, et al., 2020; Foulsham & Kingstone, 2017; Risko & Kingstone, 2011). More effort put in the comprehension process can change the way texts are navigated (Radach & Kennedy, 2004). For example, readers may feel compelled to read the text with few long-ranging nonlinear movements, considering that linear reading is often assumed to be 'the correct way' to read (Wohl & Fine, 2017).

Furthermore, estimates of long-ranging nonlinear navigation may be skewed as eye-tracking studies rarely allow readers to freely navigate texts in the lab. The text is often presented a sentence or a paragraph at a time and participants are not given the possibility of navigating to previous sections of the texts (e.g., see Faber, Krasich, et al., 2020). As a result, long-ranging nonlinear navigation is rarely measured. When linearity of reading has been studied in interviews, however, readers frequently report extensive nonlinear navigation. For example, an interview study by Milne (2021) showed that 'good readers' tend to study the content structure of a text before committing to reading it, whereas findings by Garces-bacsal and Yeo (2017) indicated that unmotivated readers occasionally skip parts of the text by long-ranging forward leaps to finish the text faster.

Similarly to linearity, readers vary in their *reading speed*. Frequency of regressions and forward leaps result in slower and faster speed, respectively (Rayner et al., 2010). However, speed also varies as a function of readers' fixation durations (Rayner et al., 2010). Rayner (2009) indicates that the average fixation duration for readers of English is 225-250 ms, however, the duration of fixations varies considerably in connection to reading skill and text difficulty. Highly skilled readers can use shorter fixations to comprehend a text, whereas a lower reading ability is connected to slower processing that results in longer fixations durations (McGeown et al., 2015; Rayner et al., 2010). Similarly, when a text is difficult to comprehend, the reader needs to slow down their reading speed by using shorter saccades and longer fixations (Miller, 2015; Van Den Broek et al., 2009), whereas easier or more predictable texts can be read fluently with a faster speed (Kuperman et al., 2010). Practice with reading improves our reading skills, and accordingly, individuals who read large amounts of text can use longer saccades and shorter fixation durations when reading (Rayner et al., 2016), resulting in a fast reading speed (McGeown et al., 2015; Rayner et al., 2016).

The majority of previous research has focused on 'deep reading' which reflects a speed at which a reader can comprehend a text in full. Findings by Brysbaert (2019) indicated that, on average, adults 'deep read' English, narrative texts at 260 words per minute (wpm)[3]. This deep reading rate varies in relation to the reader's skill and the difficulty of the text and how much focus is put on reading it (Brysbaert, 2019). Findings by Carver (1984) indicated that skilled readers' top limit for comprehending a text in full is 1000wpm, whereas Rayner et al. (2016) suggest that most readers are unlikely to exceed 400wpm.

'Speed readers' have pursued to increase their deep reading speed by practice and alternative presentations of text, such as by rapid serial visual presentation with which words are shown briefly in the same spatial location so that saccades can be eliminated (Rayner et al., 2016). As a result, they claim to be able to comprehend full novels within minutes, however, with variable success (Rayner et al., 2016). Findings by Dyson and Haselgrove (2001) and Nell (1988b) indicated that calculating a maximum deep reading speed in relation to the reader's usual reading rate can produce a reliable estimate. Findings by Dyson and Haselgrove (2001) showed that participants could fully comprehend text with a speed up to 2.5 times their natural reading rate. These laboratory-based findings were echoed by Nell (1988b) who observed avid readers' speed during reading of a novel, and found that the maximum deep reading speed was on average 2.6 times faster than participants' usual reading rate.

The lower threshold of deep reading has been suggested to be easier to estimate. Findings by Brysbaert (2019) and Clark and Foster (2005) showed that adults fluent in English rarely read slower than 100wpm in English if the reading task is their primary activity and engagement is not hampered by mind-wandering or task-switching. Low profiency in the read language, or learning difficulties such as dyslexia, on the other hand, can result in slow deep reading speeds (Altemeier et al., 2008; Brysbaert, 2019).

Deep reading is often considered to be the gold standard for reading, however, it is likely that readers frequently read at speeds that exceed deep reading. 'Skim reading' involves selective reading of a text by skipping sentences or paragraphs (Duggan & Payne, 2009), whereas deep reading is characterised by reading the text in full. Skimming is often guided by a reading strategy with which the reader attempts to gather important information from the text without reading through all of it (Duggan & Payne, 2009; Reader & Payne, 2007). To do this, readers make inferences about the structure and content of a text, and use

[3] Reading speed varies in relation to the read language (Brysbaert, 2019). For example, word length and writing system have a considerable influence on how fast text is processed (Brysbaert, 2019). In this review, we focus on reading speeds in English as the studies presented in this thesis were conducted with English texts.

headings and text formatting as a guide for which parts of the text they should focus on (Duggan & Payne, 2009). Findings by Duggan and Payne (2009) indicated that the decision on whether to read a part of a text or skip it during skim reading is made on the level of paragraphs: when the participants were placed under time pressure to comprehend a text, they prioritised reading the beginning of each paragraph. The authors suggested that the readers used the beginning of a paragraph as a guide on whether they should read it in full, or if it could be skipped to save time. Skimming often occurs when the reader has little time to read a text in relation to its length (Reader & Payne, 2007), but individuals may also skim read text to progress through a text faster (Milne, 2021), or they may do so, for example, to find their position in the text following nonlinear navigation or task-switching. Skim reading speeds are likely to be connected to readers' average deep reading speed: findings by Duggan and Payne (2009) indicated that an individual deep reading a text at 225wpm skim reads at a speed higher than 600wpm, indicating that skim reading may be at least 2.5 times faster than deep reading.

In addition to skimming, readers may scan or browse texts. Scanning is a visual search strategy during which the reader looks for keywords that they have identified as meaningful (Brysbaert, 2019). During scanning, the reader moves their eyes rapidly across a text in search of a keyword, and thus, in contrast to skimming, the majority of the text is not read (Brysbaert, 2019; Grinberg, 2018). Instead of reading the text, the reader focuses on key features, such as word length or the first letters in each word to find a match for their keyword (Brysbaert, 2019). This visual search requires lower-level processing than reading, and accordingly, it can be carried out considerably faster than skimming or deep reading. Chung (2002) suggested that no more than a gist of the text is processed if the reader's speed increases past 1000wpm, and thus skimming is unlikely to occur at speeds that exceed 4 times the reader's deep reading speed. Browsing, on the other hand, describes a navigation strategy rather than a reading speed. During browsing, the reader aims to move from one section of the text to another, and to do so, they turn pages rapidly, reading with very little of the text (Reader & Payne, 2007). Whereas scanning involves a visual search of a text, browsing is often used to find a specific location in the text (Reader & Payne, 2007) or it can be employed to oversee the text structure, for example, by inspecting the length of chapters in a book (Milne, 2021).

Table 2.1 provides an overview of the speed categorisations. The categories allow us to understand readers' motivations in varying their speed, however, in reality, readers move flexibly between different reading speed categories (Reader & Payne, 2007). For example, Wohl & Fine (2017) describe 'active skim reading' as a technique that readers use to identify sections of interest in a text so that they can slow down and deep read them. Similarly, browsing is often used in succession with other reading speeds (Reader & Payne, 2007); for example, the reader may alternate between browsing the text and scanning for keywords if they are looking for a specific section of a text.

Table 2.1

Thresholds for Different Reading Speed Types Based on Findings from Previous Research

	Min	Max
Slow reading	0	100wpm
Deep reading	100wpm	2.4-2.6 * Baseline
Skimming	2.4-2.6 * Baseline	4 * Baseline
Scanning	4 * Baseline	1s on Page
Browsing	1s on Page	-

Note. Slow reading is used to describe any reading speeds below deep reading. 'Baseline' indicates a reader's natural baseline reading speed.

2.3 Reader Characteristics of Reading Behaviour

Previous studies have shown a strong connection between the reader and their reading behaviour: individual differences, such as attitudes towards reading, social influences, motivation, and working memory capacity, influence the ways in which we read (Johann et al., 2020; Merga, 2017a; Schiefele et al., 2012). In this section, we review research on the association between these *reader characteristics* and reading behaviour. First, we assess the connection between demographics, personal characteristics, and behaviour, followed by findings on the relationship between reading motivation, electronic reading experience, and reading behaviour.

2.3.1 Demographics and Personal Characteristics

Although reading is often seen as a solitary activity, reading behaviour is connected to our social connections and environments (Merga, 2017a). A global study on adults' reading frequency by GfK (2017) indicated that culture can have a considerable influence on reading behaviour: whereas only 37% of Belgians were found to read at least once a week, 70% of

Chinese adults reported that they read once a week or more often. Reading engagement can be affected by the availability of reading materials in different parts of the world (Broeder & Stokmans, 2013), however, findings by Breton (2021) indicated that differences in social encouragement of reading may play a more prominent role. Social structures vary in how education is valued, and as a result, culture influences how much time is spent on studying and self-development, such as reading (Breton, 2021). Collectivist cultures place a strong emphasis on education and high achievement for the common good, which can result in a high reading amount (Breton, 2021; Kambara et al., 2021).

Across cultures, individuals' level of education and socioeconomic status have been associated with reading frequency (GfK, 2017; Rogiers et al., 2020). More highly educated and wealthier individuals tend to read more often and in greater amounts (GfK, 2017). This gap has been in part attributed to a difference in *print exposure*: children who grow up in homes with many books are more likely to have storybooks read to them by carers, which contributes to their reading ability (Mol & Bus, 2011). Skilled readers are more likely to excel in reading-related tasks in school, which further encourages them to read frequently and cultivate increasingly strong reading skills (Mol & Bus, 2011). Reading skills can contribute positively to the child's confidence in school, making them more likely to succeed academically and, as a result, pursue high levels of education (Mol & Bus, 2011). Furthermore, skilled readers are more likely to become avid readers, and thus, cultivate a high level of print exposure for their own children (Nolan-Stinson, 2008; Rettig & Schiefele, 2023).

Indeed, family and friends can have a considerable influence on an individual's reading behaviour. Questionnaire findings by Kaiser and Quandt (2016) showed that avid readers' book ownership and reading frequency allowed them to stand out from their social group as a 'reader'. The authors suggest that this social identity encourages readers to obtain books and read them frequently in a variety of settings, so that they can be seen by others as a reader. This relatively stable social identity can boost the reader's motivation to read, resulting in an even higher reading frequency (Schutte & Malouff, 2007). Similarly, social circles can discourage reading engagement. Children tend to feel unmotivated to read if their family and friends do not appreciate reading as an activity (Garces-bacsal & Yeo, 2017; Wilkinson et al., 2020). In adults, readers can fall prey to what Nell (1988b) labelled as 'the elitist fallacy', the inaccurate belief that sophisticated and intelligent readers should solely read socially acclaimed literature. These readers are likely to read infrequently, as discussed later in relation to reading motivation.

Similarly, reading behaviour has been connected to the readers' gender. Women and girls have been found to read more frequently and more in volume than men and boys (De Sixte et al., 2021; Jabbar & Warraich, 2022). Girls tend to have higher reading motivation than boys (Jabbar & Warraich, 2022), and they generally persist in reading books for longer (Alter & Russell, 2016). In contrast, men have been found to skim read texts more often (Liu & Huang, 2008). In addition to differences in behaviour, gender has been connected to contrasting reading material preferences. Women report a higher preference for fiction, and men tend to be more inclined towards reading nonfiction (Jabbar & Warraich, 2022). Historically, gender discrepancies have dictated what material was available to women, and from the beginning of the 20th century, fiction reading was seen as a largely feminine activity (Mckay et al., 2021). These historical influences can affect material selection today, however, the differences may also span from the ways in which men and women approach reading: whereas men are more likely to pursue an understanding of a new topic, women tend to read to feel entertained (Jabbar & Warraich, 2022; Liu & Huang, 2008). These motives are likely to influence behaviour, as discussed in the following section on reading motivation.

In addition to gender, age has been connected to reading behaviour. Recreational reading engagement has been found to decline from adolescence to young adulthood (Bushman, 1997; Wilkinson et al., 2020). This decrease has been linked to increasing reading demands in schools, which may leave pupils little time and motivation to read in their free time (Allred & Cena, 2020; Wilkinson et al., 2020). Furthermore, children have been found to receive more frequent encouragement to read for pleasure compared to adolescents or young adults (Wilkinson et al., 2020). Frequent reading is often seen as essential for children's development, however, the role of reading engagement may be neglected once the individual has gained fundamental reading skills. This low reading frequency has been found to continue to adulthood (Woodlet & Mantell, 2020). Working adults report that they struggle to find the time for reading among their daily responsibilities (Quick Reads & Billington, 2015; Woodlet & Mantell, 2020).

A large body of previous literature has indicated that cognitive resources affect the ways in which we read. Readers vary in their working memory capacity, which can influence their ability to ignore distractions and comprehend text (McVay & Kane, 2012). As a result, some readers find it more difficult to stay focused on a text than others and they may task-switch more often (McVay & Kane, 2012). Furthermore, findings by Johann et al. (2020) showed a link between reading speed and cognitive resources. In the study, children's performance in working memory, inhibition ability and fluid intelligence tests was positively correlated with their reading speed, suggesting that these executive functions are connected to reading rate.

Disorders and disabilities can influence reading behaviour (Altemeier et al., 2008; Zentall & Lee, 2012). Dyslexia is characterised by difficulty in decoding word meanings and turning the written word forms into pronounceable sounds, phonemes (Snowling et al., 2020). As a result, reading can feel effortful for the reader, which can make them vulnerable to distractions (Snowling et al., 2020). Similarly, attention deficit hyperactivity disorder (ADHD) can make the reader feel distracted and frustrated while reading (Zentall & Lee, 2012). Difficulty focusing on the text as a result of ADHD can make it difficult to create a coherent understanding of the text content (Zentall & Lee, 2012). Although the role of cognitive resources is therefore considerable in reading behaviour, it is not discussed in detail here as it was not measured as part of the studies reported in this thesis. Instead, see Lonergan et al. (2019) and Peng et al. (2018) for an overview.

2.3.2 Reading Motivation

Motivation has been recognised as a key predictor of reading engagement. Already in 1899, Arnold emphasised that engagement in reading is driven by the desire to do so. Similarly, Huey (1908) suggested that *"[o]ne cannot read naturally when he reads for reading's sake. […] The child does not want to learn reading as a mechanical tool. He must have a 'personal hunger' for what is read."* (pp. 304-305). Reading long-form fiction requires considerable effort that is sustained over multiple reading sessions. To do so, the reader needs to be motivated (Schiefele et al., 2012).

Reading motivation is a multidimensional construct which reflects the 'drive to read resulting from an individual's beliefs about, attitudes toward, and goals for reading' (Conradi et al., 2014). It describes the direction of action, such as reaching for a book or avoiding reading, and the energy put into the reading task (Ryan et al., 2019). Motivation does not only describe the reasons or motives for engaging in an activity, but it encompasses a variety of unobservable constructs which together influence an individual's behavioural, affective, and cognitive outcomes (Reeve, 2012; Ryan & Deci, 2017; Vallerand, 2000). For example, interest towards reading and reading attitude, which describe a positive orientation toward reading and a set of acquired feelings towards reading, respectively, predispose the individual to engage in or to avoid reading (Conradi et al., 2014). Similarly, beliefs about one's capability to read a text, the value of a reading activity, and one's identity as a reader contribute to their reading motivation (Conradi et al., 2014).

A variety of theories have been proposed to capture the function of motivation. The theories vary in how motivation is conceptualised, but also what are the key variables that influence and maintain it. A conceptual review by Conradi et al. (2014) showed that overall, there is low consensus on the most appropriate theory to capture reading motivation, and motivational variables are often used inconsistently in reading research. For example, *motivation, interest, attitude* and *self-concept* have been used synonymously despite of their conceptual differences (Conradi et al., 2014; Petscher, 2010). This has made it difficult to synthesize findings from the field (Anders Mazzoni et al., 1999; Conradi et al., 2014).

In this thesis, we adopt the Self-determination theory by Deci and Ryan (1985) and Deci and Ryan (2000) with the extension of Vallerand (2000)'s Hierarchical Model of Motivation as our theoretical framework of reading motivation. To explain why this approach is appropriate for the current research, we review some of the most popular motivation theories and explore their differences. We will then discuss how motivation can influence reading behaviour, relying on findings from a variety of studies that make use of different motivation theories. To make this possible, we explore how the theories can be reconciled despite their differences.

2.3.2.1 The Self-determination Theory

Early theories described motivation by individuals' physiological instincts, needs, and drives (e.g., instinct theory by McDougall (1923), hierarchy of needs by Maslow (1943), and the drive theory by Hull (1943)). Following the cognitive revolution in psychology, mid-20th-century theories explored internal sources of motivation (Morris et al., 2022). White (1959) recognised that exploration and play are differently motivated from work, whereas DeCharms (1968) found that individuals who felt that they were able to cause their own actions, and thus they had an internal 'locus of control', were more likely to succeed in the activity. Similarly, Deci (1971) noticed that internal and external sources of motivation result in different outcomes: when participants' motivation was driven by enjoyment of a task, they persisted in working on it, whereas participants who were given monetary compensation stopped as soon as the reward was withdrawn. These findings led to a distinction between *intrinsic* and *extrinsic motivation* (Deci & Ryan, 2000; Reiss, 2004). The former describes motivation that is driven by internal reasons, such as enjoyment or curiosity (Deci & Ryan, 2000). Avid readers tend to be intrinsically motivated and so they read simply because they enjoy reading (Schiefele et al., 2012). In contrast, extrinsic motivation arises from instrumental motives, and therefore, an extrinsically motivated reader reads to gain something or to avoid a punishment (Deci & Ryan, 2000).

Deci and Ryan (1985) argued that the intrinsic/extrinsic dichotomy represents a polarised view of motivation. Whereas intrinsic motivation is expected to be driven by enjoyment of the activity, extrinsic motivation is often assumed to reflect motivation that is fully externally regulated by rewards and punishments (Deci & Ryan, 2000). However, a reader's motivation can fall in between these two extremes (Ryan & Deci, 2000b). For example, an individual may read because they wish to learn more about a topic that they enjoy, and therefore, their reading engagement is autonomous and regulated by themselves, even though the motives for reading are instrumental as the reader does not read purely for the sake of reading. Focusing on the extremes of motivation fails to capture this complexity (Deci & Ryan, 1987; Ryan & Deci, 2000b).

As a result, The Self-determination theory (SDT) by Deci and Ryan (1985) expanded the intrinsic/extrinsic dichotomy into a continuum of increasingly self-determined action. According to SDT, motivation does not have to be fully intrinsic to result in positive outcomes (Ryan & Deci, 2000b). Instead, any autonomous motivation can support sustained engagement in an activity, and so a differentiation between *autonomous* and *controlled* motivation types is a better measure for the quality of motivation (Deci & Ryan, 2000).

Autonomous motivation describes voluntary engagement in an activity that the individual finds interesting and worthwhile (Deci & Ryan, 2008b). Readers with *internally regulated* autonomous motivation read simply because they enjoy reading (Deci & Ryan, 2000). However, autonomous motivation may also be regulated by *identification* or *integration* (Deci & Ryan, 2000). A reader who experiences identified regulation of autonomous motivation recognises the importance of reading, and thus reads voluntarily in their free time (De Naeghel et al., 2012). For example, a reader with identified regulation may read to learn about a topic, not because of any external demands, but to satisfy their own curiosity (De Naeghel et al., 2012). Thus reading is an instrumental, but an autonomously motivated activity. Similarly, integrated regulation describes voluntary engagement in an activity for instrumental reasons (Deci & Ryan, 2000). A reader experiences integrated regulation of autonomous motivation if they identify themselves as a reader, and so they read simply because reading is congruent with their identity (Deci & Ryan, 2008a). All three autonomous motivation types have been connected to sustained persistence in reading and a high reading frequency (De Naeghel et al., 2012).

Controlled motivation, on the other hand, describes a drive that is not regulated by the readers themselves (Deci & Ryan, 2008b). *External regulation* of controlled motivation describes what many previous researchers have conceptualised as extrinsic motivation: it indicates that the reader does not endorse the reading activity, and instead, they read solely because of external demands (Ryan & Deci, 2000b). For example, a pupil who is reading a book because it is required of them for school is likely to experience externally regulated motivation. In the absence of homework in adulthood, reading becomes an increasingly self-led activity, and as a result, few adults may experience external regulation. However, their motivation may nevertheless be controlled: *introjected regulation* of controlled motivation describes extrinsic motivation that is partly internalised by the individual (Deci & Ryan, 2000). Instead of external pressure, introjected regulation is driven by anxiety and shame (Deci & Ryan, 2000). For example, an individual who reads because they believe that not reading is shameful experiences introjected regulation. Similarly, a reader with introjected regulation of controlled motivation may read only socially acclaimed books if they fall prey to what Nell (1988a) described as the ‘elitist fallacy’. These readers believe that to be a sophisticated reader, they should only read socially acclaimed, ‘high-brow’ novels, regardless if they enjoy them or not (Nell, 1988a). As a result, the reader’s engagement is not controlled by an external force, but by internalised external pressure (Deci & Ryan, 2008b).

According to SDT, the motivation types are independent and mutually exclusive (Deci & Ryan, 2008a). Therefore, a reader with internal regulation of autonomous motivation (henceforth referred to as ‘intrinsic motivation’, see Figure 2.1) reads primarily because of their enjoyment of reading as an activity. The intrinsically motivated reader is likely to appreciate the instrumental benefits of reading, such as learning about a new topic or enhancing their reading skill, and thus they could score highly in extrinsic motivation questionnaires, however, due to their internally regulated motivation type, they would continue to read in the absence of these instrumental benefits (Deci & Ryan, 2008a). Indeed, multiple studies have shown that introducing rewards, deadlines, or monitoring can turn autonomous motivation into controlled motivation (Cherubini et al., 2020; Deci et al., 1999;

Pelletier et al., 2022). Deci et al. (1999) suggest that incentives are perceived as controlling and coercive, signalling to the individual that the activity is not worth doing in the absence of external pressure.

Where a reader falls on the spectrum of motivation is dependent on the fulfilment of three *basic needs* (Deci & Ryan, 2000). To achieve autonomous motivation to read, the reader needs *autonomy* in selecting their own reading materials, *relatedness* via social encouragement to read, and sufficient *competence* to read their selected texts (Deci & Ryan, 2008a). Thwarting any of the basic needs results in controlled motivation, whereas support for them can facilitate autonomous motivation (Deci & Ryan, 2000). The impact of the basic needs depends on the readers' perception of them (Deci & Ryan, 2000). Therefore, the individuals' genuine reading competence, autonomy or relatedness do not influence motivation beyond the person's own beliefs (Deci & Ryan, 2000). It follows that a competent reader may not feel sufficiently competent to read a text, and therefore, the basic need of competence remains unfulfilled, regardless of the reader's performance in standardised tests.

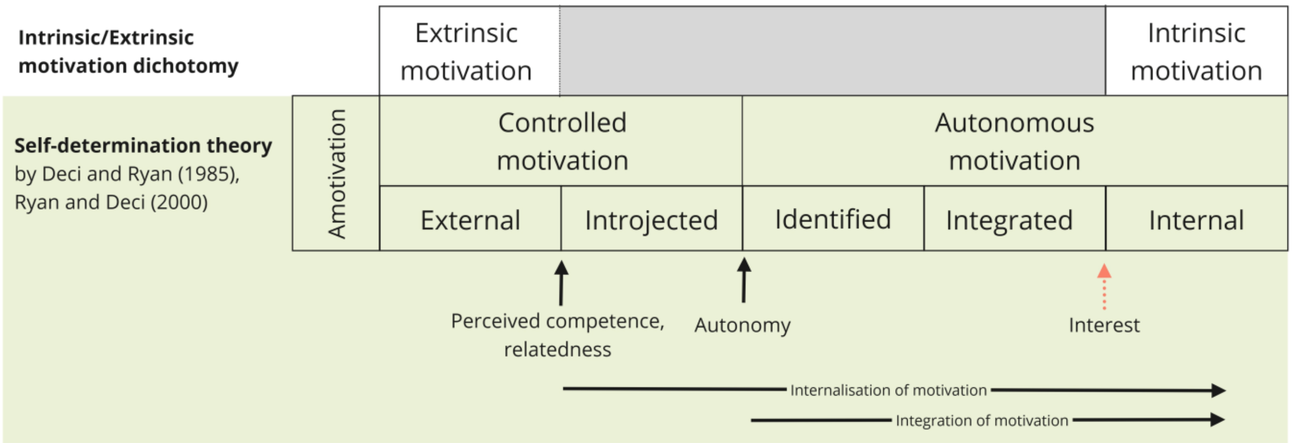
According to Ryan and Deci (2000b), the basic needs influence motivation at different stages of the motivation continuum (see black arrows in Figure 2.1). Facilitating basic needs of competence and relatedness support the individual in *internalising* the motivation regulation (see horizontal arrow in Figure 2.1), and thus a reader who feels capable of reading a text and supported by their family and peers may experience introjected regulation of controlled motivation rather than external regulation (Ryan & Deci, 2000b). Support for the basic need of autonomy, on the other hand, is a critical element for the regulation of motivation to be *integrated* so that the reader can experience autonomous motivation (see horizontal arrow in Figure 2.1; Ryan & Deci, 2000b).

Finally, motivation can become intrinsic if all basic needs are met, and the reader is interested in the activity (see orange, dotted arrow in Figure 2.1; Ryan & Deci, 2000b). Interest, therefore, acts as a bedrock for intrinsic motivation, although it can be experienced as part of other motivation types as well (Ryan & Deci, 2000b). Findings by Ryan and Connell (1989) showed that school children with external regulation of controlled motivation were least interested in a task, followed by students whose motivation was regulated by introjection. Autonomous motivation types were increasingly highly correlated with interest, with the highest association connected to intrinsic motivation (Ryan & Connell, 1989). SDT conceptualises interest as a requirement of internally regulated autonomous motivation, but it can also present in internalised extrinsic motivation types (Ryan & Deci, 2000b).

SDT provides a powerful framework to study situational motivation, such as the drive to read a particular text. However, reading motivation is multidimensional, and it is likely to be connected not only to the reader's situational drive, but their long-term goals, interests, and attitudes (Conradi et al., 2014). Indeed, avid readers tend to view a variety of reading activities positively and feel autonomously motivated to engage in them, whereas reluctant readers may avoid reading even when presented with a compelling text (Gilson et al., 2018). To capture this complexity, Vallerand (2000) expanded SDT with the Hierarchical model of motivation.

Figure 2.1

Motivation Type According to the Self-determination Theory



Note. The figure shows three levels of increasingly specific motivation types, from intrinsic-extrinsic dichotomy to controlled-autonomous motivation continuum, and motivation regulation types. Motivation types according to the intrinsic/extrinsic motivation dichotomy is shown in the top level and the Self-determination theory by Deci and Ryan (1985; Ryan & Deci, 2000) is shown by the areas shaded in light green. The intrinsic/extrinsic motivation dichotomy shows how motivation was commonly conceptualised in extremes - from the most extrinsic motivation to the most intrinsic (Deci & Ryan, 1985). The grey area indicates the gap between the two motivation types that was expanded on by the Self-determination theory. The light-green shaded area shows the self-determination continuum from amotivation to autonomous motivation. Different regulation types (external to internal) describe how internalised and integrated the motivation is. The vertical arrows show how basic needs (competence, relatedness, and autonomy, indicated by the solid, black arrows) determine motivation at different sections of the continuum, whereas interest underlies intrinsic motivation (also referred to as internal regulation of autonomous motivation, illustrated by the orange, dotted arrow). Finally, the horizontal arrows show how the regulation of motivation becomes increasingly internalised and integrated, starting at introjected and identified regulation, respectively. We expect motivation types to vary across multiple levels, see Figure 2.2

2.3.2.2 Hierarchical model of motivation

The Hierarchical Model of Motivation describes how motivation can vary across three levels - situational, contextual, and global (Vallerand, 1997; see Figure 2.2). The highest level, global motivation, describes a person's tendency to engage in activities with autonomous or controlled orientation, depending on their personality and previous life experiences (Vallerand, 2000). Contextual motivation, on the other hand, describes motivation towards a specific activity, such as reading (Vallerand, 2000). Accordingly, avid readers are likely to have autonomous motivation on the contextual level, and so they appreciate reading as an activity and gravitate towards reading in varied contexts. Situational motivation can tell us about a reader's motivation towards reading a specific text (Vallerand, 2000).

In this thesis, we focus on the contextual and situational levels of motivation as they can be used to represent reading motivation. The global level represents an individual's overall perspective on life, and so it influences motivation across a variety of domains (Vallerand, 2000). However, global motivation cannot be conceptualised in relation to reading specifically, and so contextual and situational levels are considered to be more consistent with the aims of this thesis.

In accordance with SDT, each hierarchical level represents a separate motivation continuum, from amotivation to internally regulated autonomous motivation (see Figure 2.1). Motivation may not be uniform across the three levels, and for example, an avid reader with autonomous contextual motivation can experience controlled motivation situationally if their basic needs are not met in relation to a specific text (Vallerand, 2000). This effect was illustrated in an interview study by Judge (2011) as avid readers reported avoiding required reading from school, and instead, they continued reading self-selected books that were more interesting for them. Similarly, an infrequent reader with controlled motivation on the contextual level can have a positive experience with reading a particular text, resulting in autonomous motivation on the situational level. For example, an infrequent reader in a study by Ivey and Johnston (2013) reported that coming across an interesting section while browsing a book suddenly aroused their interest, which led them to go back to the beginning of the book and read it to completion.

The motivation levels influence each other via top-down and bottom-up processes. According to Vallerand (2000), intrinsic motivation on the global level inclines the individual to approach new activities with intrinsic motives, and thus they are more likely to experience autonomous motivation on the contextual and situational levels as well. Similarly, the contextual level influences the situational: an avid reader is likely to approach reading individual texts with more enthusiasm than individuals with controlled contextual motivation. For example, an avid reader in a study by Nolan-Stinson (2008) indicated that she is happy to give any new book a chance to impress, even if the genre does not generally appeal to her. The bottom-up process, on the other hand, indicates that an individual who experiences multiple positive experiences with reading on the situational level, can develop autonomous motivation on the contextual, and eventually, on the global level (Vallerand, 2000). As a result, previous experiences with reading can have a considerable influence on later reading engagement. A pupil who experiences low autonomy support in school due to required reading may later experience controlled motivation towards reading as an activity (Allred & Cena, 2020; Vallerand, 2000). Indeed, interview findings by Teravainen-Goff et al. (2022) showed that previous negative experiences with reading is one of the most common reasons why adults may avoid reading later on. Similarly, positive experiences on the situational level can result in autonomous contextual motivation, as described by an interviewee in a study by Rosenthal (1995, p. 30):

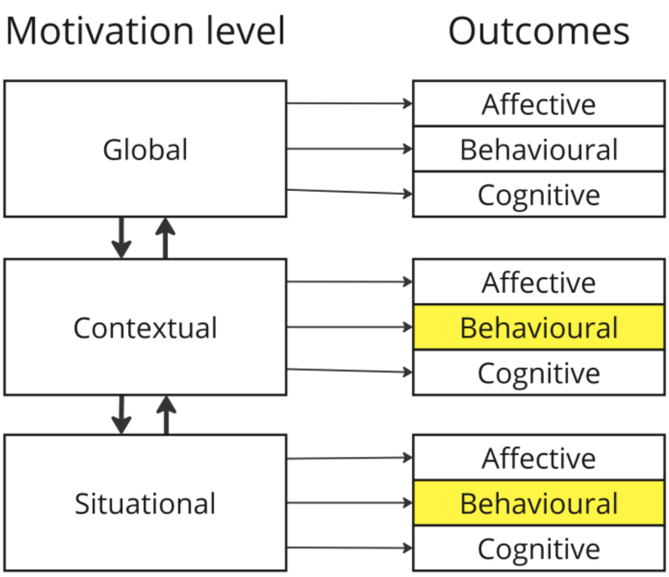
> *“Well, for some reason, I started the book and I actually enjoyed it. In fact, I loved the book and read all four hundred pages. I kept thinking, “You’re reading a book and liking it. What happened?” Then I picked out another book all by myself and read that one. Wow! I liked to read! I discovered the adventure of being in someone else’s shoes and following their thought process. It was fun. I could put all my own issues to rest and step into another’s mind and see how they handled things. So after thirty-five years of hating reading, something happened. I am not sure what, but*

now I like to read. This doesn't mean I'm a great reader, but a whole new world has opened up to me."

In addition to the levels of motivation, Vallerand (2000) provides a framework for studying the consequences of motivation. Motivation on each level can result in affective, cognitive, or behavioural effects, with the most positive consequences connected to more autonomous motivation types. For example, on the situational level, autonomous motivation can result in positive emotions (affective consequence), a higher level of attention dedicated to the text (cognitive consequence), and higher reading persistence (behavioural consequence). On the contextual level, affective consequences may mean that an autonomously motivated reader starts to regard reading as an enjoyable activity, they may improve their reading ability as a cognitive consequence, and they may start reading more frequently as a behavioural consequence. Indeed, reading behaviour can be considered to be a consequence of the readers' motivation type on the contextual or situational levels (see Figure 2.2).

Figure 2.2

The Hierarchical Model of Motivation by Vallerand (2000)



Note. The three motivation levels (global, contextual, and situational) describe motivation types (see Figure 2.1) in increasingly specific contexts. The three levels influence each other via both top-down and bottom-up processes, and each level of motivation is connected to affective, behavioural, and cognitive outcomes of motivation. This thesis focuses on the behavioural outcome of motivation on the contextual and situational levels (see highlight).

2.3.2.3 Alternative motivation theories

Self-determination theory has been recognised as one of the most dominant theories of reading motivation (Conradi et al., 2014), and Vallerand (2000)'s model makes it widely applicable. However, previous research has offered multiple alternative approaches that focus on different motivational variables. Whereas SDT and the hierarchical model of motivation pursue to quantify the quality of motivation in relation to basic needs (Deci & Ryan, 2000; Vallerand, 2000), other theories such as the social cognitive theory by Bandura (1977) and the expectancy-value theory by Eccles and Wigfield (2020) focus on the expectations and values in motivated behaviour.

Social Cognitive theory by Bandura (1977) proposes that motivation to complete a task is founded on individuals' *self-efficacy* - the belief that one is capable of completing the task. This variable is similar to SDT's basic need of perceived competence, and so self-efficacy does not only reflect of reading ability, but it describes the extent to which an individual believes themselves capable of influencing the outcomes of reading (Deci & Ryan, 2000). Individuals with high levels of self-efficacy are motivated to engage in an activity to bring about their desired outcome (Jang et al., 2015).

Social cognitive theory is commonly used in education to study children's motivation to learn to read (Schiefele et al., 2012; Urhahne & Wijnia, 2023). For example, findings by Niemivirta and Tapola (2007) indicated that enhancing children's self-efficacy with positive feedback significantly increased their interest and persistence with a difficult reading task. Higher levels of self-efficacy enhance the pupils' motivation which allows them to work diligently to read complex materials (Niemivirta & Tapola, 2007). Indeed, the social cognitive theory treats motivation as a unitary construct, and so a reader has more or less motivation in relation to their self-efficacy (Ryan et al., 2019).

The Social Cognitive theory was expanded by Eccles (1984) in the Expectancy-value theory. The theory suggests that motivation is not only reflected by readers' self-efficacy, but also by the subjective *task value* of the activity (Eccles & Wigfield, 2020). Therefore, a motivated reader believes themselves capable of reading a text, and they appreciate reading as an activity. Eccles (1984) divides task values into four groups to describe the drive behind an individual's actions: readers may be motivated to read a book if they feel proud of doing so (attainment value), if they believe reading can teach them something (instrumental value), if they do not want to be seen as someone who does not read (cost value), or because they appreciate reading as an activity (intrinsic value; Eccles, 1984; Eccles & Wigfield, 2020). These values guide readers' behaviour and performance in the reading task: findings by Wigfield and Guthrie (1997) showed that children with an intrinsic value to read and high levels of self-efficacy engaged in reading more frequently in their free time compared to their peers.

Social Cognitive and the Expectancy-value theories have been criticised for their focus on constructs that are related to reading motivation but which do not describe 'genuine' motivational drives (Schiefele et al., 2012). Unlike SDT, the theories focus on capturing motivation by its antecedents, such as task value and self-efficacy. This is useful, for example, to understand children's reading motivation in classrooms so that teachers can identify emerging motivations and interrupt any negative attitudes that could result in low reading ability (Schiefele et al., 2012). Indeed, these theories have been found to be effective in studying reading motivation in children, especially in academic settings (Schiefele et al., 2012). However, their application to studying the quality of motivation in adults has been questioned (Deci & Ryan, 2000). In contrast, SDT has focused on explaining the quality of motivation, rather than its precursors (Deci & Ryan, 2000).

Whereas SDT, social cognitive theory, and the expectancy-value theory aim to describe motivation in a variety of domains, Guthrie and Wigfield (2000)'s reading engagement model describes motivation specific to reading. The theory posits that reading engagement is driven by three domains of motivation: self-efficacy, intrinsic and extrinsic motivation, and social motivation (Wigfield, 1997). Therefore, readers who engage deeply with a text are highly motivated to read it, they believe they can comprehend the text and they use efficient reading strategies while reading it, and they take part in social activities surrounding literacy, such as book discussions.

To measure reading motivation, Wigfield (1997) further divided the three categories in the reading engagement model into 11 reading motivation aspects that can be used to understand the reader's primary motivations to read. Self-efficacy was divided into reading efficacy and challenge, which were used to describe the reader's belief of being able to successfully read a text and the satisfaction of mastering a complex idea in a text. Intrinsic motivation was expected to be driven by curiosity towards a topic, the importance of reading, and involvement with a text, whereas extrinsic motivation was connected to avoidance of reading, the desire to outperform others, reading to achieve good grades, and reading to receive reaffirmation or recognition from others. Finally, social motivation was divided into the wish to share meanings from a text with friends and family, and compliance with external requirements to read texts. The subcomponents were found to predict children's reading motivation well (Wigfield, 1997).

Unlike SDT, the reading engagement model treats motivation as an additive construct (Deci & Ryan, 2000; Wigfield, 2000). The authors argue that readers can experience intrinsic and extrinsic motivation simultaneously, and therefore, their engagement can be led by both instrumental and intrinsic values at once (Guthrie et al., 1996). Indeed, Wigfield (2000) indicates that a higher amount of motivation, regardless of type, results in stronger reading engagement. Previous studies have indicated that intrinsic and extrinsic motivation tend to be positively correlated (e.g., Wang & Guthrie, 2004), which Guthrie et al. (1996) interpret as support for their additive motivation theory. In contrast, SDT suggests that the correlation is due to intrinsically motivated individuals appreciating the instrumental benefits of an activity, although their engagement is not driven by them (Deci & Ryan, 2000).

Guthrie and Wigfield (2000)'s reading engagement model was developed on the basis of interviews and focus groups with elementary school students. Indeed, previous research has placed far more attention on children's rather than adults' reading motivation (Merga, 2017c; Schiefele et al., 2012). Adults face different responsibilities and demands on their time than children, and as a result, it is unclear to what extent theories on children's reading motivation can be adapted to use with adults. Ryan and Deci (2000a) point out that motivation is likely to become increasingly self-determined with age as individuals gain autonomy in their everyday lives. Furthermore, adults are likely to treat reading as a relatively private activity compared to pupils who are frequently encouraged to share their reading progress in school (Schutte & Malouff, 2007).

Schutte and Malouff (2007) studied how the domains in the reading engagement model generalise to adult populations. Their findings suggested that the 11 aspects of motivation proposed by Guthrie and Wigfield (2000) could be grouped into four separate domains: reading as part of the self, reading efficacy, reading to do well in other realms, and reading for recognition. Adults who scored highly on the first domain felt that reading is an essential part of their identity, and thus they reported that reading is important for them, they enjoy sharing books with friends and family, and they feel that others recognise them as a reader. Efficient readers, on the other hand, reported enjoying challenging texts that improve their reading skills, whereas individuals scoring high on reading to do well in other realms reported that they read to perform well at work and university, and to learn new things. Finally, adults who read for recognition indicated that they primarily enjoy the positive recognition from others remarking on how much they have read. These domains combine measures from the three categories recognised by the reading engagement model, indicating low support for the theory in adult populations (Schutte & Malouff, 2007). Instead, Schutte and Malouff (2007) note that the findings remind of the regulation types described in SDT: adults scoring high in the 'reading as part of self' domain are likely to experience intrinsic or integrated regulation of autonomous motivation, 'reading efficacy' and 'reading to do well in other realms' are similar to identified regulation which is driven by the recognition that reading can help the reader to learn new things, whereas 'reading for recognition' mirrors introjected regulation of controlled motivation. SDT may, therefore, provide a reliable theoretical framework to study adults' reading motivation.

Our aim is to measure adults' quality of motivation towards recreational reading in general and towards a specific narrative text. This information is compared to the participants' reading behaviour to study how motivation is associated with the ways in which adults read. Accordingly, we consider SDT with the extension of the hierarchical model of motivation to be the most appropriate theoretical framework for this thesis.

The framework provides us a theoretical basis to understand which variables are key for adults' reading motivation, and in turn, how motivation can influence adults' reading behaviour. However, despite the theoretical differences, a variety of different motivational variables have been found to be positively correlated. For example, findings from a study by Howard et al. (2021) indicated that intrinsic motivation is connected to high levels of self-efficacy and positive goal orientations, and therefore, motivated readers are likely to feel that they can influence the outcomes of the activity. Similarly, a study by Wigfield and Guthrie (1997) showed that intrinsically motivated readers feel more confident about their reading ability, they tend to have positive attitudes towards reading, and they regard reading as a valuable activity. A meta-analysis by Urhahne and Wijnia (2023) showed that motivation theories tend to share a common focus on the direction of action, and therefore, they can be grouped into an integrative model of motivation. Due to the complexity of motivation theories, the integrative model is similarly elaborate (Urhahne & Wijnia, 2023), however, it showcases how findings from studies relying on different motivation theories can be interpreted in support of each other. As a result, the remainder of the literature review is not limited to previous research that conceptualises motivation according to SDT and the hierarchical model of motivation. Indeed, this limitation would result in an incomplete understanding of how motivation can influence behaviour considering that findings by Conradi et al. (2014) indicated that only 20% of reading research made use of SDT despite of its position as the most dominant theory of motivation in reading.

2.3.2.4 Motivation and Reading Behaviour

According to the hierarchical model of motivation by Vallerand (2000), reading behaviour can be considered to be a consequence of motivation on the contextual and situational levels (see Figure 2.2), and therefore, readers' motivation should influence their reading behaviour. Indeed, previous research has made connections between readers' motivation and reading frequency, persistence, task-switching frequency, speed, and linearity of reading.

More autonomous motivation has been robustly associated with a higher reading frequency and amount (Van Ammel et al., 2021). It is plausible to expect that avid readers with autonomous motivation on the contextual level read more often than their peers with contextual controlled motivation. Indeed, a study by Nolan-Stinson (2008) showed that avid readers yearn to read, and they carry reading material with them in case they have a sudden opportunity to read for pleasure. This finding was mirrored in interviews by Rosenthal (1995) as avid readers described reading books while waiting at stoplights, during lulls in conversations, and in any unexpected situation that gives them a pocket of time. This flexible reading engagement is likely to result in frequent reading sessions. For example, 'Adair' described how she finds the time to read even during anxious moments (Rosenthal, 1995, p. 103)

> *"I carry books in my car. Once I got a flat tire. It was a very hot day but I was completely happy and absolutely calm because I could read. I had a little lawn chair in the back, which I set up beside the road, and I was very sorry to see the repair truck when it came to rescue me."*

In addition to flexible reading engagement, motivated readers are likely to read frequently because they prioritise reading over other leisure activities (Ivey & Johnston, 2013). For example, an avid reader in an interview study by Nolan-Stinson (2008) indicated that *"if I have free time, what I gravitate towards is reading"* (p. 45). Indeed, findings by Garces-bacsal and Yeo (2017) showed that motivated readers tend to watch less TV and they spend less time on the web compared to infrequent readers.

In contrast, controlled motivation on the contextual level is likely to discourage frequent reading engagement. Findings by Teravainen-Goff et al. (2022) showed that low motivation can result in the individual avoiding all reading activities in the absence of external pressure to read. This 'aliteracy' - which is characterised by reluctance to read despite the individual's sufficient reading skill (Chong, 2016) - has been found to affect approximately 30% of young adults in the UK (Teravainen-Goff et al., 2022). Aliterate adults find little enjoyment in reading, and for example, a reluctant reader in a study by Rosenthal (1995) indicated that reading has little value compared to the *"immense time and effort [it takes] to sit down and read a book"* (p. 26).

Similarly, controlled motivation on the situational level is associated with a low reading frequency (Van Ammel et al., 2021; Zare et al., 2023). Difficult and uninteresting texts discourage the individual from reading, whereas interesting and enjoyable books are read more often (Fulmer et al., 2015). A qualitative study on adolescents' reading habits by Ivey and Johnston (2013) showed that uninteresting books that were assigned to them resulted in avoidance of reading and a low reading frequency. However, once the students were allowed to select their own reading materials, and thus their basic need of autonomy was supported, they reported spending extended periods reading, as frequently as they could. For example, 'Kely' remarks that,

> *"[b]efore this year, we kind of had to read books they assigned to us, so I'd pretend to read it, and I just wouldn't care about books at all. But now they give us a choice if we want to read it, where we get to pick the book that we read. I actually read it instead of pretending to read it"* (p. 261).

Text selection can have a considerable impact on reading motivation, and as a result, on reading frequency (Ross, 2000). Compared to avid readers, reluctant readers tend to have less experience in selecting books that are appropriate for their reading skill and interesting for them (Ross, 2000). As a result, they may be more likely to experience controlled motivation on the situational level and read the selected book infrequently.

Motivation towards the text encourages the reader to read it frequently, but also persist in reading it (Ainley et al., 2002; Brinda, 2011). In a study by List et al. (2019), participants were asked to read through multiple expository texts to form an argument on a challenging topic. The findings showed that time spent on each text was connected to participants' situational interest: participants persisted in reading texts that they were most interested in, regardless of the importance of the text for completing the task. Similarly, findings by Fulmer and Frijters (2011) indicated that autonomous motivation can result in persistence, even when the text is difficult. In their study, adolescents were given the option to stop reading a demanding text halfway through. Students who showed higher situational motivation were more likely to continue reading it, whereas low motivation to read the text was connected to low reading persistence. These findings were mirrored in an interview study by Ivey and Johnston (2013); adolescents indicated they were likely to persist in reading a difficult book if they were motivated to find out what happens next in the story.

Avid readers have been found to be equally likely to give up on a difficult or disinteresting text as infrequent readers (Fulmer & Frijters, 2011; List et al., 2019). However, the point at which the reader stops reading is likely to be connected to their contextual reading motivation. Avid readers tend to have an internal locus of control, and therefore, they feel that they are in control of the activity and its outcome is contingent upon the effort they put into reading a text (Keller & Blomann, 2008). As a result, contextual autonomous motivation can make the reader feel responsible for their own enjoyment, and thus persist in reading even if they do not feel involved in the story from the very beginning (Taraban et al., 2000). This allows the reader additional time to become interested in the text, and thus an avid reader may decide to finish a book they at first found disinteresting. Indeed, findings by Kobo showed that avid readers finish approximately 60% of the books they purchase online, whereas the average reader only finishes 40% (Woodlet & Mantell, 2020). Readers with controlled motivation, on the other hand, are more likely to have an external locus of control which leads them to assume that the effort they put into reading does not influence their enjoyment of the text (Keller & Blomann, 2008). Instead, the reader may expect that the book should charm them and convince them to continue reading. As a result, readers with controlled motivation are more likely to stop reading a novel early on (Brinda, 2011; Taraban et al., 2000). For example, a reluctant reader in a study by Rosenthal (1995) reported that *"[i]f a book doesn't grab me in the first five pages, I don't get to the middle"* (p. 28), and 29% of respondents in a questionnaire study Teravainen-Goff et al. (2022) indicated that if they do not understand something that they read, they give up.

Whereas reading frequency and persistence are likely to be positively connected to motivation, frequent task-switching and mind-wandering have been associated with low motivation to read. Readers with controlled motivation are more likely to experience boredom and fatigue during reading, which can encourage them to gravitate towards other activities, and thus task-switch frequently (Ralph et al., 2021; Tulis & Fulmer, 2013). Similarly, boredom makes it difficult for the reader to maintain their focus on the task, and thus controlled motivation may be associated with frequent mind-wandering (Faber et al., 2018).

In contrast, autonomously motivated readers are likely to be absorbed in reading, resulting in longer continuous engagements (Levine et al., 2022). Indeed, a keen interest can cause a reader to disregard all distractions; sufficiently challenging and engaging texts can induce 'flow' which is characterised by complete immersion in a task (Csikszentmihalyi, 2014; McQuillan & Conde, 1996). During this optimal experience, readers can lose their sense of time and continue reading the book for longer than they intended, as described in interviews by Rosenthal (1995): *"Once I get hooked on whatever I'm reading, I disappear, I escape; I lose sense of whether I've been reading for half an hour or two hours; things can happen around me but I'll be so far away, I won't know what's going on"* (p. 26).

Autonomous motivation on the contextual level may similarly protect the reader from involuntary distractions. Merga (2017b) suggests that avid readers may have more experience of disregarding distractions which can help them maintain their attention on the text for longer. Furthermore, avid readers' strong reading ability and their higher sense of self-efficacy may help them focus on a text. Poor readers need to spend more effort on comprehending a text, which can cause them to feel fatigued and in need of frequent breaks (Rosenthal, 1995). A low self-efficacy, on the other hand, can result in more negative self-talk that can distract the reader from the text (Dahl-Leonard et al., 2023). 'Kevin' describes his frustration towards reading in interviews by Rosenthal (1995): "*I get embarrassed when I read, not because there's someone else around, but because I embarrass myself when I can't do it.*" (p. 36). Overall, negative emotions and fatigue can cause the reader to become distracted from the text (Afflerbach & Harrison, 2017; Taboada Barber et al., 2022). As readers with controlled motivation are more likely to attribute negative emotions to a reading task (Ryan & Deci, 2020), it would be plausible to expect them to task-switch and mind-wander more often during reading.

Task-switching and mind-wandering can force the reader to backtrack in the text, resulting in longer reading times and frequent nonlinear navigation (Clinton-Lisell, 2021). During mind-wandering, the reader continues to move their eyes across the text without attending to it (Soemer & Schiefele, 2019). As a result, the reader needs to make a regression to reread the section they missed (Chevet et al., 2022). Re-engaging with a text after task-switching can similarly result in rereading if the reader needs to remind themselves of where they left off. Findings by Iqbal and Horvitz (2007) showed that participants cycled through suspended applications when a work task was resumed following a distraction, whereas an eye-tracking study by Chevet et al. (2022) indicated that interruptions during a reading task often result in a regression to reread text. Furthermore, it is possible that nonlinear navigation is used as the task-switching event in itself: it is plausible that boredom encourages the reader to stop reading and instead browse the text to see how much they have left to read, and whether they could skip ahead to a more interesting section.

Linearity and reading speed are robustly connected to text difficulty and reading skills, as described earlier in this chapter. However, motivation may influence how the reader reacts to text difficulty: whereas unmotivated and uninterested readers have described themselves speeding through books and skipping parts of the text (Garces-bacsal & Yeo, 2017; Rosenthal, 1995), autonomous motivation can encourage careful reading (Worthy et al., 2001). For example, Milne (2021) describes a reader with controlled situational motivation who reported that they did not care whether they understood the text or not, whereas motivation encouraged readers to *"struggle through a text"* in a study by Worthy et al. (2001). Despite these promising interview findings, few experimental studies have explored this link between reading behaviour, motivation, and text difficulty. However, it is plausible to expect that readers with low motivation do not wish to spend additional time and cognitive resources on a difficult task, and so they may not react to text difficulty in the same way as motivated readers.

Avid and highly proficient readers may be more sensitive in reacting to inconsistencies in a text (Maier & Richter, 2014; Zimmerman & Moylan, 2009). They slow down at difficult parts and make regressions to understand the material, whereas infrequent readers may not notice the moment when their comprehension dwindles, and so they need to make larger and more time-consuming regressions in the text (Van Den Broek et al., 2009). Previous research has connected this disparity to issues with ‘calibration’: inexperienced readers may fail to estimate their own comprehension of a text, and as a result, neglect rereading it (Singer Trakhman et al., 2019; Zimmerman & Moylan, 2009). Indeed, low motivation has been connected to passive processing characterised by infrequent regressions and little questioning of the text content (Maier & Richter, 2014; Milne, 2021; Rosenthal, 1995).

In summary, reading motivation may influence behaviour in many different ways. Readers who are motivated to read on the situational or the contextual level are likely to read more frequently (Brinda, 2011; Fulmer & Frijters, 2011; Van Ammel et al., 2021), task-switch less (Ralph et al., 2021), and react to text difficulty by adjusting their speed and linearity of reading (Maier & Richter, 2014; Rapp et al., 2007). Controlled motivation, on the other hand, may result in reading avoidance (Deci & Ryan, 2008b). As a result, the reader may read infrequently or stop reading early on in a text (Deci & Ryan, 2008b; Woodlet & Mantell, 2020). Furthermore, controlled motivation has been connected to boredom, which can encourage task-switching and nonlinearity (Ralph et al., 2021; Weissinger et al., 1992). Readers with low motivation may also fail to compensate for low text comprehension when they are faced with a difficult text (Maier & Richter, 2014).

It is important to note, however, that our current understanding of how motivation can influence adults’ behaviour is limited as the majority of previous research has been conducted with children or adolescents (Merga, 2017b; Schiefele et al., 2012). The few available studies on adults’ motivation are largely focused on adults’ role as influencers of children’s reading motivation via parental or teacher-child relationships, instead of inspecting their motivation in its own right (Merga, 2017b). In this thesis, we assess whether the connection between behaviour and motivation can be found when observing adults’ reading behaviour.

2.3.3 e-Reading Behaviour

Electronic reading has become common with 30% of adults now reading ebooks for pleasure (Faverio & Perrin, 2022). Electronic texts are most often read on a generic multipurpose device, such as a smartphone or a tablet (Anderson, 2015; Maloney, 2015), but approximately 19% of adults also own a dedicated e-reading device (Anderson, 2015).

Electronic devices provide different affordances than traditional print books, which is likely to result in different reading behaviour (D’Ambra et al., 2019). Print reading is inherently material: the reader needs to physically interact with a book by opening it and turning its pages to read it. Each print book is its own individual object, and thus it provides unique haptic (e.g., the feel of the pages and the weight of the book) and visual (e.g., the cover design) cues for the reader. In contrast, digital devices can contain multiple different texts, and the form of the device does not provide clear cues on which text is being displayed (Kosch et al., 2021). Whereas print texts cannot be separated from their print medium, digital texts can be accessed from a variety of devices (Mangen et al., 2019). Therefore, an electronic text has no specific or unique material shape, and so it can be said to be ‘immaterial’.

The unique aspects of e-reading have the potential to support adults’ reading frequency. The immateriality of ebooks allows them to be read on portable digital devices, such as smartphones. Readers can take these devices with them anywhere they go, and so reading becomes a possibility in new situations and at new times, resulting in a high reading frequency (D’Ambra et al., 2019). Participants in a focus group study by Kosch et al. (2021) indicated that electronic reading has allowed them to read more on the go and in low lighting conditions, for example in bed before falling asleep, where reading would have been previously difficult. In addition to the enhanced portability, digital devices make reading material more widely available. Physical storage is not an issue with ebooks, and acquiring new reading material is easy from online stores and libraries (Kosch et al., 2021). As a result, readers can find electronically any book they wish to read, often at a lower cost than the print equivalent (D’Ambra et al., 2019), and read it anywhere, at any time. This can help adults incorporate more reading in their busy lives, and indeed, readers report that the portability and availability of electronic texts have made it easier for them to read flexibly in short spurts, for example during a commute or in a waiting room (D’Ambra et al., 2019; Kosch et al., 2021; Nolan-Stinson, 2008). Due to the lower cost, ebooks allow readers to experiment with new genres and authors, allowing them to read more widely (Kosch et al., 2021).

In addition to availability, electronic texts contribute to the accessibility of reading (Merga, 2017b). Portable devices are lightweight, and thus they can be easier to hold than a print book (Kuzmičová et al., 2020). Their in-built lighting allows reading in a variety of conditions, and adjustments to the reading layout, such as font size and type, can make the text easier to read (D’Ambra et al., 2019). Electronic texts go beyond the print medium, and indeed, popular e-reader applications have incorporated systems that can support reading engagement; for example, an ‘X-ray’ reference tool by Amazon Kindle allows readers to easily find references to characters and places mentioned previously in the text, without exiting the book (D’Ambra et al., 2019). In-built dictionaries and reading assistance functions, such as ‘WordWise’ by Amazon Kindle which provides automatic definitions for uncommon words in text, can help struggling readers to comprehend a text (D’Ambra et al., 2019). Indeed, adults who would not, or cannot, read in print may do so electronically (Merga, 2017b).

Despite the positive potential of e-books, few adults prefer e-reading over print books. A self-report study by Gloag and Lockey (2019) showed that approximately 60% of the adults surveyed would prefer to read a fiction book as a paperback or a hardcover, whereas only 20% would choose to read it electronically. Individuals report that they feel distractible during electronic reading (Liu, 2022), and they believe that they retain less of the text content (Vernon, 2006). Konnikova (2014) further stressed that *“people prefer physical books, not out of old fashioned attachment but because the nature of the object itself has deeper repercussions for reading and comprehension”*.

In line with users’ expectations, some previous studies have suggested that e-reading does not support reading engagement. Baron et al. (2017) argue that reading is a multisensory experience, and so the unique sensory aspects of print books are an important part of reading engagement. Similarly, McLaughlin (2016) argues that the materiality of print books *“reinforce and deepen the habit of reading”* (p. 31). Print books provide few affordances other than reading, whereas digital devices can be used for a variety of different purposes (D’Ambra et al., 2019). These affordances can become distracting to the reader, especially if the reading activity is interrupted by notifications or reminders which encourage the reader to move to another task (Hillesund, 2010; Kosch et al., 2021). Indeed, Mangen (2008) argues that the frequent distractions posed by digital devices make flow an unlikely experience electronically.

The type of digital device used for electronic reading is likely to influence readers’ behaviour (Kosch et al., 2021). Generic multipurpose devices, such as laptops, tablets and smartphones, are often used for quickly consumable and alternating content such as social media posts and brief messages, which do not require extended focus from the user (Annisette & Lafreniere, 2017). The ‘shallowing hypothesis’ suggests that this type of content promotes shallow cognitive engagement which can carry over to other electronic activities on these devices (Annisette & Lafreniere, 2017; Baron, 2021a). As individuals are used to engaging in shallow reading tasks on their smartphones and tablets, they can find it difficult to maintain their engagement when reading a long-form text (Baron, 2021a). Even the mere potential of new stimuli on digital devices can result in a psychological urge to frequently disengage from the reading material (Hillesund, 2010; Mangen, 2008). This shallow mindset may discourage deep reading of text in favour of scanning and skimming, and result in frequent nonlinear navigation to get through the text quickly (Hakemulder & Mangen, 2024).

Dedicated e-ink e-readers, such as Amazon Kindle Paperwhite or Kobo Clara, aim to provide a distraction-free e-reading experience. These devices have few affordances beyond reading or library navigation (D'Ambra et al., 2019), and the electronic ink screen has optics comparable to that of print books (Zambarbieri & Carniglia, 2012). Despite these improvements, researchers have suggested that there is a link between e-reading on a dedicated device and shallow focus; for example, Knight (2016) points out that *"[w]hen holding a Kindle it's easier to wonder what else is on the store, what the battery life is and other trivialities, that can distract from the story or article"*.

The enhanced availability of reading materials online may have a negative effect on reading engagement. Findings by Kosch et al. (2021) indicated that readers can feel overwhelmed with the amount of material available online. The oversaturation of choice may lead the reader to wonder whether they should persist in reading one book, or move on to others. Indeed, previous studies have indicated that reading persistence may be low electronically. Braslavski, Likhosherstov, et al. (2016) studied reading behaviour via user data on a Russian ebook subscription site, and found that only 36% of books started were read to completion. The low completion rate may reflect the nature of the reading platform which provides readers with a large selection of texts to select from (Braslavski, Likhosherstov, et al., 2016).

Overall, previous research suggests that individuals may read electronic texts at a faster speed, using nonlinearity frequently to advance in the text (Dyson & Haselgrove, 2000; Hakemulder & Mangen, 2024; Liu, 2005). The abundance of distractions can cause frequent task-switching (Hillesund, 2010; Mangen, 2008) and competing reading materials may encourage the reader to stop reading a book early on (Braslavski, Likhosherstov, et al., 2016).

Some have suggested that this electronic reading behaviour results in poor text comprehension (e.g., Baron, 2021b). Indeed, a small but consistent print benefit has been found for the comprehension of expository texts (Clinton-Lisell, 2021; Delgado et al., 2018; Kong et al., 2018). Findings by Singer Trakhman et al. (2019) indicated that this inferiority effect may be due to poor calibration: undergraduate students estimated their comprehension test performance to be higher when reading electronically, when in reality their scores were better in the print reading condition. Indeed, readers may be neglecting the use of important meta-cognitive reading strategies electronically, and thus they may read texts faster (Mangen, 2008; Singer Trakhman et al., 2019) and reread less often compared to print reading (Latini et al., 2020; Margolin et al., 2013). However, the effect has not been replicated for narrative texts: findings by Schwabe et al. (2021) showed that participants' comprehension of a print and electronic text was comparable when reading the first 20 pages of a "high-brow novel".

Similarly, findings by Mangen et al. (2019) indicated that adults' recall of narrative text content was not affected by the reading medium. Instead, their results showed that e-reading may undermine readers' understanding of their location in an electronic text. Whereas print books' text is fixed on a page, digital texts (with the exception of PDF documents) tend to be fluid: the text layout is dynamic to make sure that it can be comfortably viewed in a variety of configurations, with a different font and on different devices. When the pages are turned, the electronic text layout can change. This can be problematic for navigation as readers have been found to rely on the text layout, such as the visual structure of paragraphs or the location of headings on a page, as a reminder of the location of previously read passages (Schilhab et al., 2018). Without these consistent 'text anchors' regressions backwards in an electronic text can be difficult to carry out, and readers can get 'lost' in the document (Schilhab et al., 2018).

Difficulty engaging in e-reading and navigating electronic texts may be connected to low levels of experience with electronic reading (Leu et al., 2015). Early theories indicated that adults who have been surrounded by and grown up with technology are "digital natives", and so they can withstand the distracting nature of digital devices by effective multitasking and they can navigate electronic environments with ease (Kirschner & De Bruyckere, 2017). However, studies have indicated that young adults are equally likely to have difficulty with electronic texts, and struggle with the distractible nature of digital devices (Kirschner & De Bruyckere, 2017). Instead, task-relevant experience with electronic tasks has been associated with better performance (Wang et al., 2014).

Individuals tend to have existing strategies that they use during reading (Vernon, 2006). *Compatibility* refers to the extent to which an individual's strategies are appropriate to use in an available format (Chau & Hu, 2001). When compatibility is low, readers can feel frustrated and distractible, and they need to exert significant effort to carry out the task (Chau & Hu, 2001). For example, a reader who uses print-specific reading strategies such as manipulating the physical pages while reading or determining the length of a book by its thickness, is likely to have trouble with electronic reading that provides different affordances. In contrast, when compatibility is high, readers find the reading format easy to use (Chau & Hu, 2001; Lazar et al., 2003).

Most adults have little experience of reading long-form texts electronically, and thus, they may lack strategies to deal with electronic texts (Yoo & Roh, 2019). A study by Vernon (2006) showed that 61% of undergraduate students preferred print reading, and had difficulty using an electronic book due to incompatibility of their strategies with the reading format. More recently, a study by Yoo and Roh (2019) found that the majority of adults have a strong print preference which makes them unwilling and unprepared to read electronically. Electronically experienced participants, on the other hand, were found to have a mental schema of electronic reading strategies that was consistent with the reading medium, and so they found electronic books easy to use (Yoo & Roh, 2019).

Adults with a high level of task-relevant electronic reading experience may be more prepared to read electronically (Yoo & Roh, 2019). Their reading strategies do not depend on the tangibility of the material (Yoo & Roh, 2019), and for example, Eshet-Alkalai (2004) suggested that these individuals can navigate electronic documents with ease without feeling spatially disoriented in virtual environments. They may also make more use of electronically unique affordances, such as progress bars, hyperlinked menus and tables of content, when navigating a text (Yoo & Roh, 2019). Furthermore, D'Ambra et al. (2019) suggested that electronically experienced readers may be confident in relying on percentages as markers of progress in electronic texts, whereas a reader with print-specific reading strategies may be more likely to rely on page numbers.

These compatible reading strategies may support the electronically experienced readers' comprehension ability. Findings by Vernon (2006) showed that the screen inferiority effect in expository reading disappeared when participants were allowed to select their own reading format. The authors suggested that participants who chose the electronic reading medium were more experienced in using it, whereas previous studies showing a print benefit have forced participants to use one reading format. Considering that print-based strategies remain dominant (Yoo & Roh, 2019), it is likely that these studies miss the effect of task-relevant electronic experience. Whereas readers with a strong print preference are likely to feel like they cannot comprehend text as well electronically (Yoo & Roh, 2019), electronically experienced readers report no difference in their comprehension ability (Kosch et al., 2021).

Interview findings by Kosch et al. (2021) showed that electronically experienced readers become equally immersed in electronic and printed texts. Instead, the interviewees indicated that digital devices allow books to be read distractibly, in situations where interruptions are likely and reading sessions may be short. However, if an electronically experienced reader wishes to sit down and deeply engage in a book, they can do so equally with an electronic or a printed text (Kosch et al., 2021). Indeed, it is possible that the previously outlined negative effects of electronic environments on reading behaviour are due to a lack of task-relevant electronic experience. However, few studies have considered this possibility, relying on age-driven measures of whether readers are 'digital natives' instead.

Task-relevant experience can be gained by practice (Yoo & Roh, 2019; Zheng & Li, 2020). Therefore, it is possible that anyone can acquire strategies that support electronic reading engagement, allowing them to tap into the positive potential of e-books. According to the Technology Acceptance Model (TAM) by Davis (1989), individuals can develop a positive attitude towards a technology and start using it once they feel that it can enhance their performance in a task, and they expect the technology to be easy to use. In terms of reading, this means that a reader needs to feel that an e-book reading application is easy to use, and that e-reading is useful for them, for example, in incorporating more reading in their daily lives (Torres et al., 2014; Yoo & Roh, 2019; Zheng & Li, 2020).

It is likely that task-relevant experience requires that the individual is familiar with both using the digital reading device and reading long-form texts electronically. If the reader lacks the former, and is therefore not confident in using the device or aware of its affordances, they may find it difficult to use the device and stay focused on reading a text (Yoo & Roh, 2019). Awareness of affordances may allow readers to neglect any notifications or interactive elements, whereas an unaccustomed user is likely to feel overwhelmed by them (Vernon, 2006). However, experience using the device is unlikely to be sufficient without experience in reading long-form texts. If the reader is only experienced in using the device for rapidly changing media, they may not be accustomed to focusing on a text for extended periods of time (Gezgin et al., 2021).

In this thesis, we expect that adults need both types of experience to effectively engage in e-reading. For example, a reader who is experienced in reading electronically on a dedicated e-ink e-reader may not be prepared to read an ebook on a generic multipurpose device that requires them to inhibit the influence of distractors, such as notifications. Similarly, an individual who is experienced in reading digital short texts, such as social media messages or short articles online, may find it difficult to extend their focus during a long-form text, in accordance with the shallowing hypothesis.

2.4 Task-contexts of Reading Behaviour

In addition to reader characteristics, the context in which a book is read is likely to influence behaviour. Long-form texts such as books are often read in multiple reading sessions (e.g., Tukh et al., 2019). Considering that adults' everyday responsibilities fluctuate, so do the circumstances of reading for pleasure. Reading behaviour is likely to vary in relation to the reading location, and timing of reading sessions. Furthermore, previous studies have suggested that the reading task, text properties, and even the reader's previous reading behaviour may be connected to the ways in which a narrative text is read.

2.4.1 Locations and Timings of Reading Sessions

Adults frequently report struggling to find time to read for pleasure (Woodlet & Mantell, 2020). In response to their daily responsibilities, adults vary their reading frequency from day to day (Merga, 2017b). This was illustrated by an avid reader in a study by Merga (2017b):

> *"I have very little free time. I used to read on average a book every two or three a night, often one a night. Nowadays I get patches when I can read and I might get through three books in a week, but then not get to read any more books for another four or six weeks."*

Indeed, findings from a study by Braslavski, Likhosherstov, et al. (2016) showed that adults' reading patterns vary across the week. They analysed log events from an online book subscription service, and found that adults tend to read more at the beginning of the week (Monday to Wednesday) compared to the weekend. This is intriguing considering that adults could be expected to have more leisure time during the weekend, and thus more time for reading. However, it is possible that reading is disregarded in favour of other leisure activities (Braslavski, Likhosherstov, et al., 2016). In fact, readers often report that they find it difficult to select reading over less effortful activities such as watching TV or socialising in their free time (Rosenthal, 1995). Similarly, holidays have been connected only to a minor increase in reading frequency (Gallik, 1999; National Endowment for the Arts, 2007). Adults tend to report that they intend to read more during a holiday, however, findings by the National Endowment for the Arts (2007) showed that, on average, adults spent only 6 more minutes on reading on holidays compared to normal weekdays.

During holidays and weekends free time is limited and so adults may wish to spend it on socialising and taking part in activities that they could not do during their working week. In contrast, during the COVID-19 pandemic, many were confined in their homes with no possibility to work, socialise, or travel. As a result, many adults had fewer demands on their time than ever before (Droit-Volet et al., 2020). Studies on the effect of the pandemic on reading engagement indicated that adults read more frequently during the lockdowns than usual (Boucher et al., 2020; Salmerón et al., 2020), indicating that extended free time can result in a higher reading frequency. Moreover, reading had an important role in the adults' lives, as it can provide an escape from distressing news (Boucher et al., 2020), and it has been associated with an improvement in anxiety (Levine et al., 2022).

How do avid readers fit reading into their daily lives? A study by Smith and Stahl (1999) on readers' demographics indicated that enthusiastic readers are unlikely to have fewer responsibilities or more leisure time than infrequent readers. Instead, it is possible that avid readers read more flexibly due to their enjoyment of reading as an activity (Nolan-Stinson, 2008; Sheldrick Ross, 1999). They carry reading materials with them, in case they have a small pocket of time for reading (Garces-bacsal & Yeo, 2017). For example, an interviewee in a study by Nolan-Stinson (2008) reported that he fits reading *"into the busy flow of [his] life by seizing moments to read"* (p. 81), and results from interviews with avid readers by Sheldrick Ross (1999) showed that reading is *"interwoven into the texture of [avid readers'] lives"* (p. 787).

Flexible reading engagement is likely to result in frequent task-switching and variable reading times, locations, and reading session durations. For example, during a commute, the reader needs to make sure that they get off the bus at the correct stop and remain mindful of others around them. As a result, it is plausible to expect that reading during a commute is made of short sessions and frequent disengagements to check how close the individual is to their destination. Similarly, reading on a subway station or in a waiting room requires the individual to maintain focus on their surroundings (Rosenthal, 1995). In these situations, reading is a secondary, extraneous activity. For an avid reader who yearns to read more, reading in this fragmented manner is likely to be the preferable option to not reading at all (Kosch et al., 2021; Nolan-Stinson, 2008).

Interview findings from Kosch et al. (2021) indicated that e-reading can support this flexible reading engagement. The respondents indicated that e-books allow them to read for short periods of time in new locations: *"I'm more likely to unpack the Kindle than an analogue book […] in situations where there's only time for two, three, five pages"* (p. 209). Whereas print books can be arduous to carry and unpack, e-reading allows the reader to quickly access the position in which they left off (Kosch et al., 2021). Furthermore, Kuzmičová et al. (2020) suggest that avid readers of electronic books may have gained practice that allows them to juggle external demands during reading:

> *"[I]ndividual m-readers [people who read on their smartphones] who frequently read in checkout lines may in fact develop environment-resistant immersive skills. […] [T]he performance of multiple tasks in quick succession, for example, finding the last passage read, reimmersing in the text, all the while non-consciously monitoring the progression of the waiting line, can also improve due to training"* (p. 9-10)

It follows that some of the fragmented electronic reading behaviour observed by previous studies (e.g., Liu, 2012) may be a characteristic of reading on the go, rather than distractible reading engagement.

Whereas avid readers are likely to incorporate reading in their days flexibly, infrequent readers may feel that they need to commit significant time to reading (Sheldrick Ross, 1999). For example, an interviewee in a study by Rosenthal (1995) mentioned that *"[Novels] take a lot of time and I have to concentrate on what's going on. I would want to sit down and read most of the book and I don't want to take the time; I have other things to do, like put dinner on the table, wash and iron, so it's better not to get involved in a book at all"* (p. 40). Indeed, many wish to prepare a perfect reading environment before reading for pleasure; interviewees in studies by Merga (2017b) and Rosenthal (1995) mentioned that they require a comfortable reading setting and generous amounts of time for reading. Reading is seen as an important, even sacred activity, that cannot be taken lightly (Wilkinson et al., 2020). As a result, these individuals tend to read infrequently, struggling to find adequate time for a perfect reading session (Sheldrick Ross, 1999).

2.4.2 The Effect of Text and Reading Task

Narrative texts are often read recreationally with the primary intention of enjoying the story. However, as described in the motivation section of this chapter, readers can have a variety of different motives to read a text. These motivations influence the reading task, which in turn, has an effect on the way in which the text is read (Hahn & Keller, 2023). For example, findings by Horiba (2000) showed that participants who read a text to assess its coherence made more backward and forward inferences to compare the new and previously mentioned information in the text, whereas those who were free to read the text as they wished compared the text content more on their own previous knowledge. Although the authors did not report on quantitative reading behaviour, previous studies have indicated that making backward and forward inferences encourage the reader to read the text nonlinearly to reread previous sections (Milne, 2021; Zwaan et al., 1995), whereas reflecting on one's own experience can result in mindwandering (Milne, 2021). Similarly, Hahn and Keller (2023) found that showing a question before the reading task had a significant effect on participants' reading behaviour: previewing the question was connected to faster reading speeds and more word skipping to focus on the key parts of the text, and so previewing the question changed the reading task into an information-seeking activity (Hahn & Keller, 2023).

In addition to the task, the text being read has an impact on behaviour[4]. As described earlier, difficult texts can force the reader to slow down their reading speed and make frequent regressions to reread material. Similarly, new texts are read differently from familiar material (Kaakinen & Hyona, 2007; Ministero et al., 2021). Avid readers frequently report rereading books that they have enjoyed (Ministero et al., 2021). Their reading behaviour is likely to vary from the first instance, however, considering that the reader knows the outcome of the story and is not surprised by plot points in the novel (Ministero et al., 2021). Furthermore, the reader does not need to make as many inferences while reading the text

[4] Previous research has shown that narrative texts are read differently from expository material (Horiba, 2000). However, this area is not reviewed here as the focus of this thesis is on narrative text reading.

(Ministero et al., 2021). Thus, it would be plausible to expect that the enhanced familiarity with the text can result in less frequent regressions and a faster reading speed.

Different book genres place different demands on the reader; whereas fantasy novels involve the reader getting to know an entirely new world, contemporary and literary fiction require the reader to keep track of different characters and their relationships. To create a coherent understanding of these stories, the reader may need to reread informative sections of the text (Milne, 2021). In addition to the genre, the importance that the reader attributes to the text can influence the ways in which it is read: socially acclaimed literature is seen as 'important' and thus readers often believe it should be read carefully in-depth, whereas books identified as 'low brow' or 'guilty pleasures' are often read digitally, in the privacy of one's own home (Mckay et al., 2021).

Books and stories tend to follow a predictable narrative structure (Brütsch, 2015). Most often, the structure follows three acts - beginning, middle, and end - each of which has its own characteristics (Brütsch, 2015). The beginning of a story sets up the plot and establishes relationships between the characters, and so it includes a great deal of information for the reader (Syd Field, 2005). Accordingly, the beginning of a story can feel difficult to get into as the reader tries to understand the setting and the characters, and get used to the author's writing style. For example, a reader in a study by Rosenthal (1995) reported that *"It usually takes the first one hundred pages of a novel before it's set in my mind, but after that, I can jump in and out and still keep the continuity."* (p. 115). Indeed, readers may stop reading a book in the beginning phase if they have trouble reading through the setting up of the plot (Goodreads, 2013).

The middle sections of a book are more likely to be engaging (Syd Field, 2005). In this section, the reader is introduced to a conflict or an obstacle that the characters need to overcome (Syd Field, 2005). The conflict creates tension in the story, and thus immersion in the story becomes more likely (Bálint et al., 2017). If the reader experiences flow, they are unlikely to disengage from the text, resulting in long reading sessions (McQuillan & Conde, 1996). It would be plausible to expect that this increased focus on the text allows the reader to read it at a higher-than-usual reading speed. However, findings by Nell (1988b) indicated the opposite. In the study, avid readers were asked to read 30 minutes of a book that they had already started, while being observed in a lab. The findings showed that readers slowed down their reading speed when reading more engaging sections of the book so that they could savour them. In contrast, less-enjoyed passages were read with a much higher reading speed. Similarly, Wolf and Barzillai (2009) argue that readers who are more involved in the reading process read the text in more depth, slowing their reading speed to fully absorb meaning.

At the end of the story, the plot reaches a resolution stage (Syd Field, 2005). The reader finds out what happens to the characters and whether they achieve what they set out to do in the beginning (Syd Field, 2005). Eye-tracking studies have indicated that readers' speed may increase towards the end of a text (Demberg & Keller, 2008; Kaakinen et al., 2018; Kuperman et al., 2010). This could indicate of the readers' anticipation of finishing the reading task, or their increasing familiarity with the writing style. However, the finding was made for expository text reading, and therefore, it is unclear whether the same effect can be observed in narrative text reading. Indeed, future research is needed to reconcile whether reading speed could be expected to decrease towards the end of a narrative text due to savouring, or increase in anticipation of the task being finished.

In addition to the location in text, readers' behaviour may vary according to the length of their reading sessions. As described previously, short sessions may be distractible if reading is a secondary activity, or if the reader is struggling to stay focused on the text. More variance is likely to occur in longer, dedicated reading sessions. At first, the reader may find it difficult to settle down to read (Rosenthal, 1995), and they may need to refresh their memory on where they left off by rereading text on the previous page (Iqbal & Horvitz, 2007). As the reader becomes engaged with the narrative, they can become immersed in the book (McQuillan & Conde, 1996). However, long reading sessions may also be associated with fatigue. Considering that reading is an effortful activity, readers can find it difficult to maintain focus on the text (Ariga & Lleras, 2011). As a result, they may experience more mind-wandering (Forrin et al., 2021), their reading speed is likely to slow down, and they may need to reread text more often (Bafna & Hansen, 2021).

Finally, the ways in which the text has been read previously may influence reading behaviour in latter sessions. For example, low comprehension in a previous reading session is likely to affect a readers' behaviour if they need to reread sections of the text to keep up with the story. Narrative texts require readers to make subtle inferences on the characters' relationships and plot events, and therefore, missing a small section of the story can result in confusion later on (Zwaan et al., 1995).

2.5 Research Aims, Questions, and Hypotheses

Across three studies, we assess whether electronic reading behaviour is connected to reader characteristics (RQ1) and task-contexts (RQ2). Hypotheses were set on the basis of previous research, and they are summarised in Table 2.2 and 2.3.

2.5.1 RQ1. Is electronic reading behaviour connected to the readers' characteristics? How?

RQ1.1 Is situational motivation connected to reading behaviour?

Previous research has indicated that situational autonomous motivation can support readers' persistence (Brinda, 2011; Fulmer & Frijters, 2011) and engagement (Faber et al., 2018; Ralph et al., 2021), and encourage frequent reading of the text (Van Ammel et al., 2021). Accordingly, we expected participants with more autonomous situational motivation to be more likely to persist reading the text (H1.1a), read it more often (H1.1b), and task-switch less frequently (H1.1c). Furthermore, previous research has suggested that situationally motivated readers may be more likely to compensate for text difficulty by varying their reading speed and nonlinearity compared to readers with controlled situational motivation (Maier & Richter, 2014; Milne, 2021; Rapp et al., 2007). In accordance, we expected situational autonomous motivation to be connected to baseline-level and slower reading speed (H1.1d) and frequent nonlinear navigation (H1.1e) if the reader finds the text difficult to read.

RQ1.2 Is contextual motivation connected to reading behaviour?

Similarly to situational motivation, previous research has connected contextual motivation with reading behaviour. Due to their internal locus of control, readers with autonomous motivation on the contextual level are more likely to persist reading texts (Keller & Blomann, 2008). Furthermore, autonomous contextual motivation has been connected to a high reading frequency (Nolan-Stinson, 2008), and less frequent task-switching (Kuzmičová et al., 2020; Merga, 2017b). Accordingly, we expected participants with more autonomous contextual motivation to persist in reading texts in the studies (H1.2a), return to them more often (H1.2b), and task-switch less frequently (H1.2c). Similarly to situational motivation, more autonomous contextual motivation may be connected to adaptive reading behaviour when the text is difficult to read, and so we expected more autonomous motivation to be connected to baseline-level and slower reading speed (H1.2d) and frequent nonlinear navigation (H1.2e) if the text is perceived to be difficult.

RQ1.3 Is task-relevant electronic reading experience connected to reading behaviour?

Finally, reading behaviour was expected to be connected to participants' task-relevant electronic reading experience. Electronic texts have unique affordances that can make them difficult to read for individuals with limited experience in using these platfroms (Yoo & Roh, 2019). Over time, readers become proficient in reading electronically and navigating virtual texts (Yoo & Roh, 2019; Zheng & Li, 2020). Accordingly, we expected task-relevant electronic experience to support readers' engagement with digital texts, resulting in stronger reading persistence (H1.3a), higher reading frequency (H1.3b), and less frequent task-switching (H1.3c). Whereas electronically inexperienced readers may neglect importance of rereading and slowing their reading speed when reading difficult texts (Clinton, 2019; Vernon, 2006), task-relevant electronic reading experience may encourage readers to use baseline-level and slower speeds (H1.3d) and use nonlinear navigation if the text is difficult to read (H1.3e).

Table 2.2

Summary of Hypotheses on (RQ1) the Relationship Between Reader Characteristics and Reading Behaviour

	Higher reading persistence	Higher reading frequency	Lower task-switching frequency	Baseline-level and slower reading speed when situational competence is low	More frequent nonlinear navigation when situational competence is low
Situational autonomous motivation is connected to...	H1.1a	H1.1b	H1.1c	H1.1d	H1.1e
Contextual autonomous motivation is connected to...	H1.2a	H1.2b	H1.2c	H1.2d	H1.2e
Task-relevant electronic reading experience is connected to...	H1.3a	H1.3b	H1.3c	H1.3d	H1.3e

2.5.2 RQ2. Is electronic reading behaviour connected to the task-context? How?

In addition to reader characteristics, task-contexts can influence the ways in which we read. We studied the connection between behaviour and task-contexts by inspecting how reading frequency, task-switching, reading speed, and linearity of reading are connected to timing and location of reading sessions, location in text, and previous events. Persistence was not assessed in relation to task-contexts due to its circular connection with the task-context variables: considering that persistence indicates how far in the text the participant has read, task-contexts variables, such as location in text and number of reading sessions, are likely to be highly correlated with it as they both reflect readers' progress through the text.

RQ2.1 Is reading location connected to reading behaviour?

Adults may read in multiple different situations and locations to fit recreational reading in their busy daily lives (Kosch et al., 2021; Kuzmičová et al., 2020; Nolan-Stinson, 2008). These varied circumstances are likely to affect reading behaviour: reading in a bus or at a public place can support frequent reading engagement, but it is also likely to result in more frequent disengagements due to noise and multitasking (Kosch et al., 2021; Kuzmičová et al., 2020). Frequent task-switching and multitasking, in turn, can result in slower reading speed (Clinton-Lisell, 2021) and frequent nonlinear navigation to reread previous sections of the text (Chevet et al., 2022). Reading in the comfort of one's home, in contrast, may support longer continuous sessions and more careful reading engagement. Accordingly, we expected that reading sessions outside of the home would be connected to higher reading frequency (H2.1a), more frequent task-switching (H2.1b), slower reading speed (H2.1c), and more frequent nonlinear navigation (H2.1d), compared to reading at home.

RQ2.2 Are location in text and timing of reading sessions connected to reading behaviour?

In addition to the readers' physical location, readers' familiarity with the text is likely to be associated with their reading behaviour. The beginning of a text can feel confusing for the reader if they need to get to know varied characters and settings (Rosenthal, 1995; Syd Field, 2005). As they read on, the fictional world becomes easier to grasp and immersion becomes more likely (Rosenthal, 1995). Furthermore, findings by Milne (2021) suggested that readers may navigate texts nonlinearly to prepare for reading it. As a result, we expected frequent task-switching, slower reading speed, and frequent nonlinear navigation to be more likely at the beginning of the text (H2.3a-c) and in early reading sessions (H2.2a-c).

RQ2.3 Is time since the beginning of a reading session connected to reading behaviour?

Readers often report struggling to settle down to read (e.g., Rosenthal, 1995). As an effortful activity, reading requires the individual to attend to the text, however, competing thoughts and other internal distractions are common before the reader becomes engaged in the text (Rosenthal, 1995). Furthermore, readers may need to refresh their memory of the text content by rereading previous sections (Iqbal & Horvitz, 2007). Later on, reading engagement may feel easier, which allows readers to comprehend the text with a faster speed. In accordance, we expected the beginning of reading sessions to be connected to more frequent task-switching (H2.4a), slower reading speed (H2.4b), and more frequent nonlinear navigation (H2.4c), compared to the end of the reading session.

RQ2.4 Can we predict reading behaviour by previous events?

Due to the complexity of reading engagement, it is highly likely that individuals vary in their reading behaviour. For example, some readers are generally more likely to task-switch or use nonlinear navigation (Kononova et al., 2016; Milne, 2021). To shed light on this research area, we assess whether reading behaviour can be predicted by previous events. Due to limited previous research, we treat this as an exploratory research question and so no hypotheses were set.

Table 2.3

Summary of Hypotheses on (RQ2) the Relationship Between Task-context and Reading Behaviour

	Higher reading frequency	Higher task-switching frequency	Baseline-level and slower reading speed	More frequent nonlinear navigation
Reading location outside of the home is connected to...	H2.1a	H2.1b	H2.1c	H2.1d
Early reading sessions are connected to...		H2.2a	H2.2b	H2.2c
Early locations in text are connected to....		H2.3a	H2.3b	H2.3c
The beginning of reading sessions is connected to...		H2.4a	H2.4b	H2.4c

Chapter 3

Methodology

3.1 Overview

Previous studies have used a variety of methods to study reading behaviour. However, due to methodological limitations, few have studied electronic reading behaviour of long-form texts, such as short stories or full-length novels, within the context of adults' everyday life. We address this limitation by using two novel methodologies. A bespoke e-reader web application was developed for this research project to measure reading behaviour on generic multipurpose devices, such as smartphones and laptops. To assess reading behaviour on dedicated e-reader devices, we compiled a dataset of user data by collecting data donations from participants who had used these devices on a third-party provider.

In this chapter, we will first outline previous methodologies that have been used to study reading behaviour. We will then describe our methodology that was employed in the experimental chapters 4, 5, and 6. The method includes the design and functionality of the e-reader web application, assessment of the user data via a pilot study, and the questionnaires that were selected for measurement of reader characteristics, such as motivation and electronic reading experience. Finally, we will describe our approach to data analysis via multilevel models, and explain how the methodologies outlined in this thesis contribute to the field.

3.2 Previous Approaches in Studying Reading Behaviour

Previous research has relied on self-reports and lab-based approaches to measure reading behaviour. Self-reports, such as interviews and questionnaires, can help us understand the readers' subjective experiences of reading. Whereas interviews allow us to collect detailed information on reading behaviour by open-ended questions, questionnaires are useful for collecting data from larger samples.

Questionnaires and interviews are used widely in reading research; however, findings obtained with these methods may be affected by errors in retrospective recall (Schwartz, 2007). Interviews and questionnaires require participants to reflect on their past reading behaviour, which can be a difficult task. Schwartz (2007) showcases how retrospective self-reports are directed by naive inferences, which can lead mistakes; for example, to estimate one’s reading frequency, individuals often compare their past reading engagement with their current reading frequency. If the comparison is favourable, the reader is likely to exaggerate their reading frequency, whereas the opposite can happen if the respondent believes that they used to read more often than they do now (Schwartz, 2007). Furthermore, retrospective reporting can be biased as individuals are likely to overestimate the duration of longer reading sessions, whereas short reading sessions may be forgotten entirely (Schwartz, 2007).

To tackle this issue, diary-methodologies and experience sampling have been used to collect self-reports from participants when the activity is engaged in, minimising the need for recall. Diaries involve participants filling in forms, for example, on the reading activities that they have engaged in throughout the day (e.g., Buchanan et al., 2015; Foasberg, 2014). Studies using experience sampling, on the other hand, use notifications to prompt participants to respond to self-report items at random time intervals (e.g., Colombo & Landoni, 2014; Tonks et al., 2021). Although these methodologies bypass the issue with retrospective recall, they may disrupt natural reading behaviour (Locher & Philipp, 2023). Indeed, diary-entries and experience sampling notifications can act as reminders to read, which can motivate participants to read more often that they would outside of the study (Schmidt & Retelsdorf, 2016).

Overall, self-reports rely on the assumption that participants can accurately and reliably report on their own experiences and behaviour. However, it is unclear to what extent readers are aware of their own reading behaviour. Previous research on meta-awareness has illustrated that individuals are often unaware of the contents of their experiences (Schooler, 2002). People tend to be poor at capturing the amount of time they spend on a task and how often they engage in an activity (Fahrenberg et al., 2007; Schmidt & Retelsdorf, 2016). Reports are likely to be particularly poor if the reader is asked to provide a specific estimate, such as the number of minutes that they spent reading a book (Schwartz, 2007). Low metacognitive awareness is particularly likely during immersive experiences; reading flow is characterised by the individual losing their sense of time and self, and therefore, readers are unlikely to be aware of their own reading behaviour during immersive reading sessions (McQuillan & Conde, 1996). Furthermore, self-reports are likely to be influenced by societal expectations (Schmidt & Retelsdorf, 2016). Reading is a socially encouraged activity that is generally associated with high intelligence (Teravainen-Goff et al., 2022). As a result, individuals may exaggerate their reading engagement, either knowingly or implicitly, to appear more favourable to the researcher (Mol & Bus, 2011).

Lab-based measures are a popular alternative to self-reports, and in particular, eye-tracking has a long history in reading research (Rayner, 1998; Tatler & Land, 2015). Eye-tracking usually involves the participants reading text on a desktop computer while their eye movements are tracked with a camera (Rayner, 1998). To accurately capture movement of the eye, the participants are asked to keep their head still by leaning on a head mount or a chin rest, and the gaze location is calibrated by asking participants to fixate on specific stimuli on screen.

Eye-tracking studies have provided invaluable information on low-level reading behaviour, during reading of individuals words, sentences, and short paragraphs. Eye-tracking during reading of longer texts is less common because the experimental setting can become uncomfortable for the participant[5]. Instead, other lab-based approaches have been used to study reading of longer texts. For example, Nell (1988b) observed avid readers' reading speed by counting the number of pages turned during a reading session in the lab.

Lab-based approaches allow meticulous study of observable behaviour by compromising ecological validity (Fahrenberg et al., 2007). The experimental settings differ from adults' natural reading environments, and as a result, the participants are unlikely to read in a lab as they do in their free time. Indeed, individuals' cognitive processes are dependent on their situational context (Kingstone et al., 2008), and thus studies with low ecological validity may not generalise outside of the lab. To understand natural reading behaviour, it is important to study it in the context of adults' everyday lives using ecologically valid and inconspicuous tools that do not disturb the reading process.

Due to methodological limitations, few studies have been able to observe reading behaviour outside of the lab. Braslavski, Likhosherstov, et al. (2016) made use of user logs from a Russian e-reader application to study reading behaviour unobtrusively. The logs included information from approximately 8000 users' reading patterns when they were using the application over 10 months. The dataset included rich information, for example, on which books the participants read and how their reading speed varied within reading sessions. Similarly, Jellybooks and Kobo have analysed user logs and reported on their findings in popular news outlets (Alter & Russell, 2016; Woodlet & Mantell, 2020). These studies have indicated that adults vary considerably in their reading behaviour and thus they showcase the

[5] Some exceptions to this include work by Hyönä and Nurminen (2006) and Reichle et al. (2010) who tracked participants reading a 12-page expository text and a full-length novel, respectively.

potential of studying reading behaviour using unobtrusive tracking methods. However, none of the datasets were obtained for research purposes, and thus limited information was captured on the participants, making it impossible to study reader characteristics of reading behaviour. Furthermore, user logs that have not been curated for research purposes are likely to be noisy. A follow-up study to Braslavski, Likhosherstov, et al. (2016) by Tukh et al. (2019) studied a subset of users who read *War and Peace* by Leo Tolstoy on the e-book reading application. The authors report that 64% of participants' reading sessions were removed as it was unclear whether the users were engaged in reading at the time.

The aim of this thesis is to address these limitations in previous research by using novel methods to study adults' natural reading behaviour.

3.3 Our Approach

The current project was conducted to enhance our understanding of adults' electronic reading behaviour on their own digital devices. Two different methodologies were used across three studies: the first two studies employ a bespoke e-reader system with embedded tracking features to observe reading behaviour, whereas the third study is based on a dataset that was compiled from data donations from users of Amazon Kindle devices. The first method was developed for this research project, and it was used to collect rich information on adults' page-level reading behaviour during reading of a short story (Chapter 4) and a full-length novel (Chapter 5). Whereas the e-reader system was used to track adults' reading behaviour across one text on a digital device with a web browser, tracking data from Amazon Kindle was used to capture reading behaviour across multiple different texts and devices, including dedicated e-ink e-readers. Together these methodologies allow us to comprehensively assess recreational reading behaviour of fiction on a variety of digital devices.

3.3.1 Method 1: The E-reader System

An e-reader system was developed in collaboration with a professional web developer. The development was first started in Spring 2017, and an early version of the e-reader system was used in a previous project on academic reading behaviours (Vuorinen, 2019). Although the early version was used as a foundation for the e-reader system, the design was considerably altered between 2019 and 2021 to match the needs of the current research project, and so it is introduced as a brand new tool to track reading behaviour. Front- and back-end implementation of the e-reader was done by the web developer, and therefore, only limited technical detail is provided. The design of the e-reader system and its functionality, however, was directed by the author.

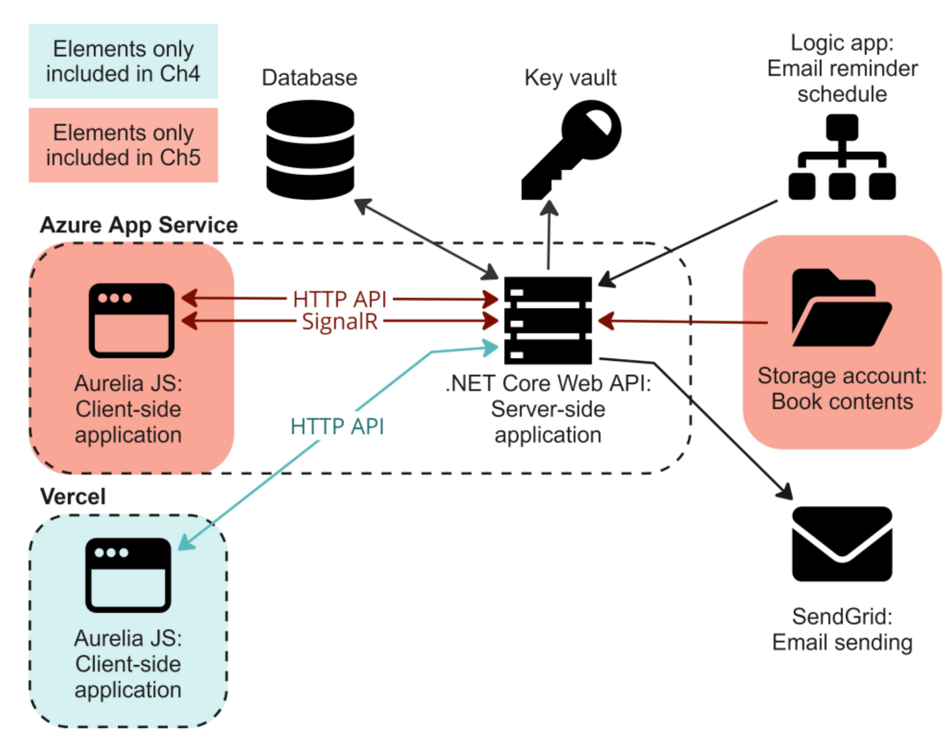
The e-reader is accessed as a website via a browser on computers and mobile devices. Participants were asked to register for an account using their email address, so that they could log in. The website includes an e-reader platform that participants can use to read a text on their own digital devices. In addition to the e-reader, the website was customised for each study to include a consent form, information sheets, questionnaires, a text selection platform, a debrief sheet, and a baseline reading speed test. Indeed, the e-reader system could be used to conduct the studies fully online, opening the potential for more widespread recruitment.

The e-reader system is a web application comprising a client-side application, a server-side application, and other server-side resources (see Figure 3.1). The client-side application is loaded on the user's device and runs on a browser. It includes the user interface of the e-reader, the embedded tracking functionality, and it communicates with the server-side application. The client-side application was built as a single-page application (SPA) using Javascript and a framework called 'Aurelia'. The server hosting the client-side application was set up in Vercel in the first study (Chapter 4), whereas Microsoft Azure was used for the study presented in Chapter 5. The server-side application was a .NET Core WEB API application written in C#, and deployed to Microsoft Azure app service. We used a single MSSQL database in Microsoft Azure SQL server to store both user data (including account information, tracking data, and questionnaire answers) and common data (including questionnaire items, and text meta-data). Text contents were stored in a Microsoft Azure storage account as a file-share that was accessible by the server-side application.

The e-reader system was developed to ensure the anonymity of participants. To this end, the participants' email addresses were encrypted, and thus this information was hidden from the web developer and the researchers. Decryption of the email addresses was necessary for sending reminder emails to the participants about the study. The reminders were sent via SendGrid and scheduled by Logic Apps in Microsoft Azure. A Microsoft Azure Key vault was used to secure access to the encryption key material. Passwords, on the other hand, were 'hashed' using a standard, secure hashing algorithm so that they were not recoverable from the database. Participants were assigned a user indicator that was used to match the questionnaire and reading behaviour data. Furthermore, efforts were taken to avoid possible triangulation of participant identity by limiting the collection of demographic information to age, gender, education level, and native language. No sensitive information was collected. These precautions were taken to make sure that the data were anonymous and could be shared for use in future studies.

Figure 3.1

Architecture of the E-reader System



Note. The elements in blue are only included in the e-reader system used in the study reported in Chapter 4, whereas the elements in red are used only in the e-reader system in Chapter 5.

3.3.1.1 Design

Our aim was to create an e-reader that would be familiar for the participants to use, and so the design of the e-reader system was inspired by popular e-book reading application such as Amazon Kindle on PC and smartphone. As a result, we used horizontal page-views on which pages are turned instead of vertically scrolled. Although horizontal page layouts are common in e-book reading applications, they are uncommon in web reading setups and online articles. Instead of page turning, web articles often provide scrollable interfaces in which text is organised vertically. The page layout can have a considerable effect on reading behaviour, as findings by Piolat et al. (1997) indicated that horizontal layouts can enhance the readers' comprehension of the material and memory for the spatial location of different segments, allowing them to make more accurate regressions backwards in the text. We expected that including the e-book specific page-view system could therefore inspire more natural recreational reading behaviour on digital devices.

Furthermore, we mimicked the dynamic text presentation that is often used in popular e-book reading applications. The text on screen was dynamically organised depending on the width of the browser window. If the device's screen width was less than 1192 pixels, the text was shown in one column, whereas on wider screens the text was organised into two separate columns (see Figure 3.2).

Similarly to popular e-book reading applications, the pages could be turned via multiple different methods. Participants could turn pages backwards and forwards by using a keyboard, a mouse, or by tapping or swiping on the side of the page. Furthermore, the text could be navigated by interacting with a progress bar at the bottom of the screen (see Figure 3.2). The progress bar indicated participants' location in the text by the length of the coloured section and by a percentage displayed on the progress bar.

Previous studies have indicated that representing a location in a text as pages within a book rather than as a percentage in the text can enhance readers' navigation electronically (e.g., Gardener, 2011; Tracy, 2018). Readers can use the layout of pages as a landmark which can guide rereading of text and improve navigation (Schilhab et al., 2018). Additionally, page numbers can enhance readers' understanding of the length of the text (Baron, 2021a). In the e-reader system, however, pages could not be estimated as the text was shown as an HTML file embedded on the web page. Similarly to many other e-readers, text on a page was fluid and it could shift when the participants navigated back and forth in the text. It would have been computationally demanding to compare the shown text to actual pages in a book, and providing an estimate of the number of page-views on a particular device may have confused participants due to the alternation in estimates when reading on different devices. Therefore, percentages were accepted as a way to show participants their location in the text.

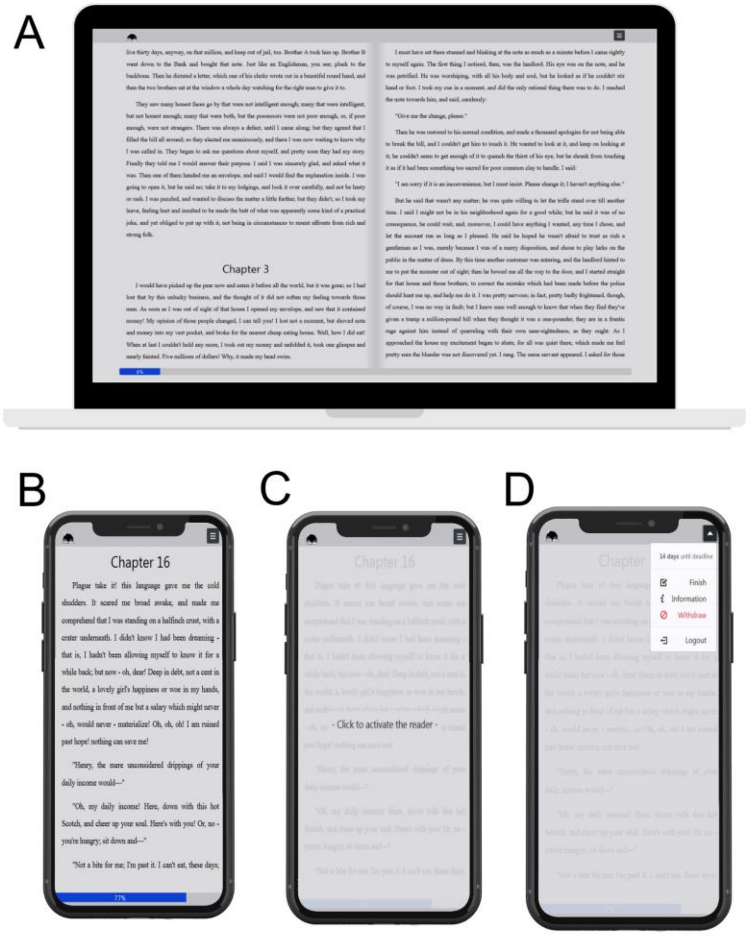
The text was shown on a light grey background with a black, size 13.2 font (font face: Times New Roman). The background and text colour combination were based on findings by Huang et al. (2019) which indicated that a light grey background with black text maximised readers' comfort in a variety of lighting conditions. E-book reading applications often provide users options to alter the reading layout, however, no customisations were included in our e-reader system to reduce noise in the data.

To estimate when the participants were engaged with the text, a text masking feature was added to the e-reader system. Opening a menu in the e-reader, unfocusing the browser window (e.g. by clicking outside the browser window or interacting with a different browser tab), or more than 5 minutes of inactivity caused the e-reader to mask the text (see Figure 3.2). Five minutes was chosen as the appropriate threshold following experimentation with the e-reader: our tests indicated that page-views displaying more than 1000 words were rare, and thus, any page-view could be read by an average reader at 200wpm in under five minutes. The mask covered the e-reader in full at 90% opacity to make sure that participants could not read the text during task-switching. Clicking or tapping on the e-reader reactivated it, removing the text mask.

Participants could use any device with an up-to-date web browser to access the e-reader system. The e-reader automatically saved participants' location in text, allowing them to switch between different devices and resume reading where they left off. In addition to automatic bookmarks, commercial e-book reading applications often provide users with the possibility to make manual bookmarks in the text. These bookmarks can be used, for example, to navigate back to a section of a text that was identified to be interesting, or to reassure the user that the system saved their place. However, no manual bookmarking was included in the e-reader system to reduce noise in the data.

Figure 3.2

Screenshots from the E-reader System



Note. A) Engaged reading view on a large device, such as a laptop, with two columns of text. B) Engaged reading view on a small device, such as a smartphone, with one column of text. C) Masked text view on a small device. The text is masked when the user unfocuses the browser or after 5 minutes of inactivity. D) Open menu view on a small device. Opening the menu masks the text.

Participants could navigate the web application with a menu shown in the right-hand corner of the e-reader system (see Figure 3.2 D). The menu could be used to log out of the e-reader and check additional information on the study. To allow participants to intuitively access this information, we used a common symbol to represent the menu (☰). In popular e-book reading applications, however, the menu symbol is often hidden in a focused reading state until the user taps or clicks in the middle of the screen. In contrast, in the e-reader system, the menu was left visible at all times. The symbol did not obstruct any of the text as the e-reader had visible margins (see Figure 3.2).

The functionality and usability of the e-reader was tested by the author, web developer and the project supervisors before data collection. The e-reader system was found to function well on various devices and web browsers. Additional feedback on the usability of the e-reader system was collected from participants as part of each study, see details in the method section of Chapters 4 and 5.

3.3.1.2 Tracking Functionality

The e-reader system uses embedded, unobtrusive tracking functions to collect data on reading behaviour. Data were collected by creating a tracking event for each action, such as opening the e-reader, a page-turn, disengagement, or using the menu. The tracking events included information to identify the participant and the text being read, and the exact time when the event was captured. Furthermore, each event had information on the user's location in text, browser information, the participant's browser window width, and event 'type'. Whereas window width and browser information helped us understand which device was used to access the e-reader, event types told us what the participant was doing. For example, a 'keyboardForward' event type indicates that the participant used a right arrow in their keyboard to turn the page forwards. Following this event, we should see an 'openPage' event to indicate that a new page has opened. See Figure 3.3 for an illustration on the event types, and an information file in a data repository at https://github.com/PauliinaV/Short_Story_Reading_Behaviour_Public/ for a full breakdown of all event types. Additionally, information was collected on the state of the e-reader, such as whether the text was masked at the time of the tracking event or not.

The tracking events were collected by the client-side application as the participant was using the e-reader, and sent to the server-side application via a HTTP request. If the request failed, it would be re-tried later in case the error was due to an unreliable internet connection. In the server-side application, the event was associated with the participant's id and stored in the SQL database (see Figure 3.1).

Figure 3.3

Illustration of the Functionality of the E-reader System Tracking Types

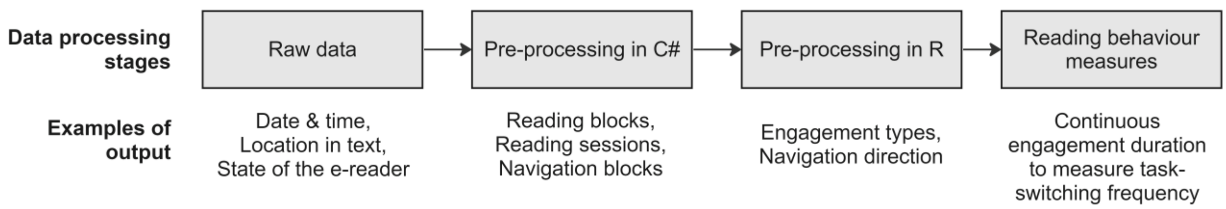
Note. Tracking ‘types’ tell us about the participants’ interaction with the e-reader. The first step illustrates the participant opening a book which is recorded by an ‘openBook’ and an ‘openPage’ tracking types. The participant then turns the page by clicking on the right side of their screen (‘clickForward’), which triggers the e-reader to open a new page (‘openPage’). The participant then opens the menu on the upper right corner of the e-reader (‘openMenu’) which activates the text mask (‘blur’).

3.3.1.2.1 Pre-processing of the Tracking Data

The raw tracking data were pre-processed first in C# and then in R before measures could be created (see Figure 3.4). Pre-processing in C# was used due to the high complexity of the tracking data. For example, identifying unique page-views called ‘reading blocks’ called for the use of a current state machine to capture the user’s progress through the recorded locations in text, a task that was more suitable for C# than R. The C# code was written and implemented by the web developer; however, the process was fully directed by the author. All analyses in R were conducted by the author independently.

Figure 3.4

Pre-processing Stages of the E-reader System Tracking Data



Events were grouped into ‘engagements’ and ‘disengagements’. If the text was visible for 1s or less, the event was categorised as a disengagement. In contrast, participants were assumed to be reading the text and thus they were engaged if the text was visible for longer than 15 seconds continuously. This threshold was used in accordance with findings by Iqbal and Horvitz (2007) which showed that resuming attention in a task following a disruption took individuals approximately 15 seconds. Any events during which the text was visible for more than 1s but less than 15s were categorised as ‘disrupted engagements’. During these events, participants may have attempted to re-engage with the text following a disruption, but they may have been unable to focus similarly to participants in the study by Iqbal and Horvitz (2007). Alternatively, these short engagements may have been due to accidental opening of the e-reader. For example, a participant may have had the e-reader system open in an alternative tab in their browser, and they may have accidentally opened it when trying to navigate to another site. To avoid bias, disrupted engagements were treated similarly to disengagements.

The events create a continuous record of participants’ reading behaviour when the e-reader is in use. Therefore, event durations could be calculated by subtracting an event’s start time from the next. Events were then grouped into reading sessions. A session began when the e-reader was opened, and ended when the e-reader was closed, or after 60 minutes of inactivity. Our focus was on understanding engagement with the text, and thus any reading sessions that lasted for less than a minute or which consisted of less than 15% engagement were removed. This threshold was reviewed in each study by visualisations, see method section in Chapters 4 and 5.

Reading speed was captured in words per minute by comparing time spent on a page-view to the number of words on each page. To create reading speed categories detailed in previous research (see Table 2.1 in Chapter 2), we used a baseline reading speed test to capture participants’ natural deep reading speed. In the test, participants read a 200-word segment of a short-story in English, *The Darling* by Anthon Chekhov (in the public domain), while their speed was measured. Participants were shown the text once they indicated that they were ready to begin the test, and they were told to press a button once they had finished reading it. If the participant advanced from the reading speed test too quickly, indicating a reading speed of over 900wpm, they were asked to repeat the test with a different 200-word segment of the story. This threshold was informed by previous findings from Chung (2002) who indicated that deep reading speeds faster than 900wpm are rare.

To classify navigation as nonlinear or linear, the tracking events were grouped into ‘navigation blocks’. Each block signified navigation into one direction at a steady speed (slow reading, deep reading, skimming, scanning, or browsing - see Table 2.1 in Chapter 2). Each navigation block was then compared to the following to categorise linearity. Any block that showed movement backwards in the text was identified as a regression (change in location < 0), whereas blocks that showed movement forwards to a position further than the next page were categorised as forward leaps (change in location > visible characters on the page). Any other navigation was identified as ‘linear’.

3.3.2 Method 2: Amazon Kindle User Data

Although the e-reader system can be used with any multipurpose devices, it is not functional on dedicated e-ink e-reader devices. These devices have fewer affordances and reading on them is therefore likely to result in different reading behaviour. Furthermore, studies by Benedetto et al. (2013) and Zambarbieri and Carniglia (2012) indicated that e-ink screens cause less eye strain compared to LCD or OLED screens that are typically used in multipurpose devices, such as smartphones. As eye strain on digital devices has been found to influence reading behaviour (Benedetto et al., 2014), reading on dedicated e-ink e-readers may result in different reading behaviour. Findings from Kosch et al. (2021) indicated that adults who use a dedicated e-reader are likely to prefer reading on it over their multipurpose devices. Therefore, focusing only on multipurpose devices that could be accessed with the e-reader system would have resulted in an incomplete picture of electronic reading behaviour.

Dedicated e-readers have become popular since the commercialisation of e-ink technology in 1997 (Desmarais, 2002). A statistical release from 2014 indicated that 32% of American adults own a dedicated e-reader device (Zickuhr & Rainie, 2014) and it is likely that their usage has since increased. Indeed, e-ink e-readers have become a popular way of reading for pleasure, and users tend to find them easy and pleasant to use (Kosch et al., 2021; Lettenmaier, 2013). The most popular dedicated e-reader brand in the UK is Amazon Kindle, which covers up to 76% of all e-readers used in the UK (Kunst, 2017).

Studying reading behaviour on e-ink e-readers is a challenge because of these devices’ limited affordances. However, it became a possibility in January 2020 when Amazon made it possible for their users to request their user data (Gartenberg, 2020; Paul, 2020). The data includes information on the user’s activities on the corresponding Amazon website from which the user placed the request (i.e., Amazon UK, Amazon US, Amazon Canada, etc.). To receive their user data, users need to send a request to Amazon which is returned in approximately 5-10 days. The user then receives access to several datasets on their Amazon activity. Among these datasets are tracking logs from Amazon Kindle.

Early experimentation with the author's user data showed that the Amazon Kindle tracking logs consist of multiple different files, including two anonymous datasets that feature information on reading behaviour. The first shows the users' actions within reading sessions, from navigation to annotation, whereas the second summarises information about the users' reading sessions. For the author, the logs covered 5 years of reading activity, detailing reading behaviour on a variety of different Amazon devices and applications.

Although the gist of the Amazon Kindle logs could be deciphered by the author, some of the information was unclear. Furthermore, it was not apparent whether the tracking logs would provide an accurate and reliable measure of reading behaviour. To address these apprehensions, we conducted a pilot study to assess how the logs were collected.

In the pilot study, we tested the tracking functionality by using five different Kindle devices and applications on a new Amazon UK account. The testing included five different types of reading sessions that were carried out on a Kindle Voyage e-ink e-reader, a Kindle Fire tablet device, Kindle Cloud web browser application, Kindle for PC downloadable software, and Kindle for Android smartphone application. The testing sets were videoed, screen captured, and tagged with time and date information (see Figure 3.5). After the testing sets, we requested the Amazon Kindle user data for the test account and compared the information in the datasets with the actions recorded in the video files.

Overall, the pilot study showed that Amazon Kindle user logs capture reading behaviour reliably. The logs recorded each of the reading sessions that were tested in the pilot study, and accurately linked each session to a unique device ID and a book indicator. Furthermore, the reading actions dataset showed that the logs could be used to accurately measure the timing of page-turns. However, the accuracy of time stamps varied, with Kindle devices (Kindle Voyage and Kindle Fire) providing the most accurate indicators of when the actions occurred, whereas the timing of logs on the smartphone app and in Kindle Cloud varied by a few seconds, and the information was completely missing from reading sessions tested on Kindle for PC. Despite this variance, the Amazon Kindle datasets were deemed to be sufficiently reliable for use in a research setting.

After the pilot study, the reading actions data was made unavailable by Amazon. As a result, the study was focused on the remaining dataset on reading sessions. The log data could be used to assess the timing and durations of reading sessions, the devices used, and the books read. In the study, participants were asked to respond to questionnaires, and request their Amazon Kindle dataset on their reading sessions via Amazon UK to donate it for research purposes. This approach allowed us to study reading behaviour across multiple different texts and devices. More information on the study design is included in Chapter 6 method section.

Figure 3.5

Pictures of the Amazon Kindle E-reader Devices and Applications Used for Testing Amazon Kindle Logs

Note. The images show the five different devices at different parts of the test reading sessions. Whereas Kindle Voyage and Kindle Fire reading sessions were captured on video, the smartphone application, Kindle for PC and Kindle Cloud were screen captured.

3.3.3 Measures of Reading Behaviour

The rich tracking data obtained from the two methods could be used to measure various reading behaviours. However, we focus on five measures of behaviour that have been discussed in previous research – reading frequency, persistence, task-switching frequency, linearity, and speed of reading. We aimed to measure these behaviours without aggregation to retain nuance in the measures.

Participants' frequency of reading a text was measured by the time in between their reading sessions (see Figure 3.6 A). This measure was used instead of the number of reading sessions to allow participants' reading frequency to vary. A long time in between reading sessions was used to indicate infrequent reading engagement, whereas a reader who returns to a text frequently was expected to have less time in between their reading sessions. The measure was computed by comparing a reading session's start time to the end time of the previous session. Therefore, each participant had $k-1$ measurements of reading frequency, where k indicates the number of a participant's reading sessions.

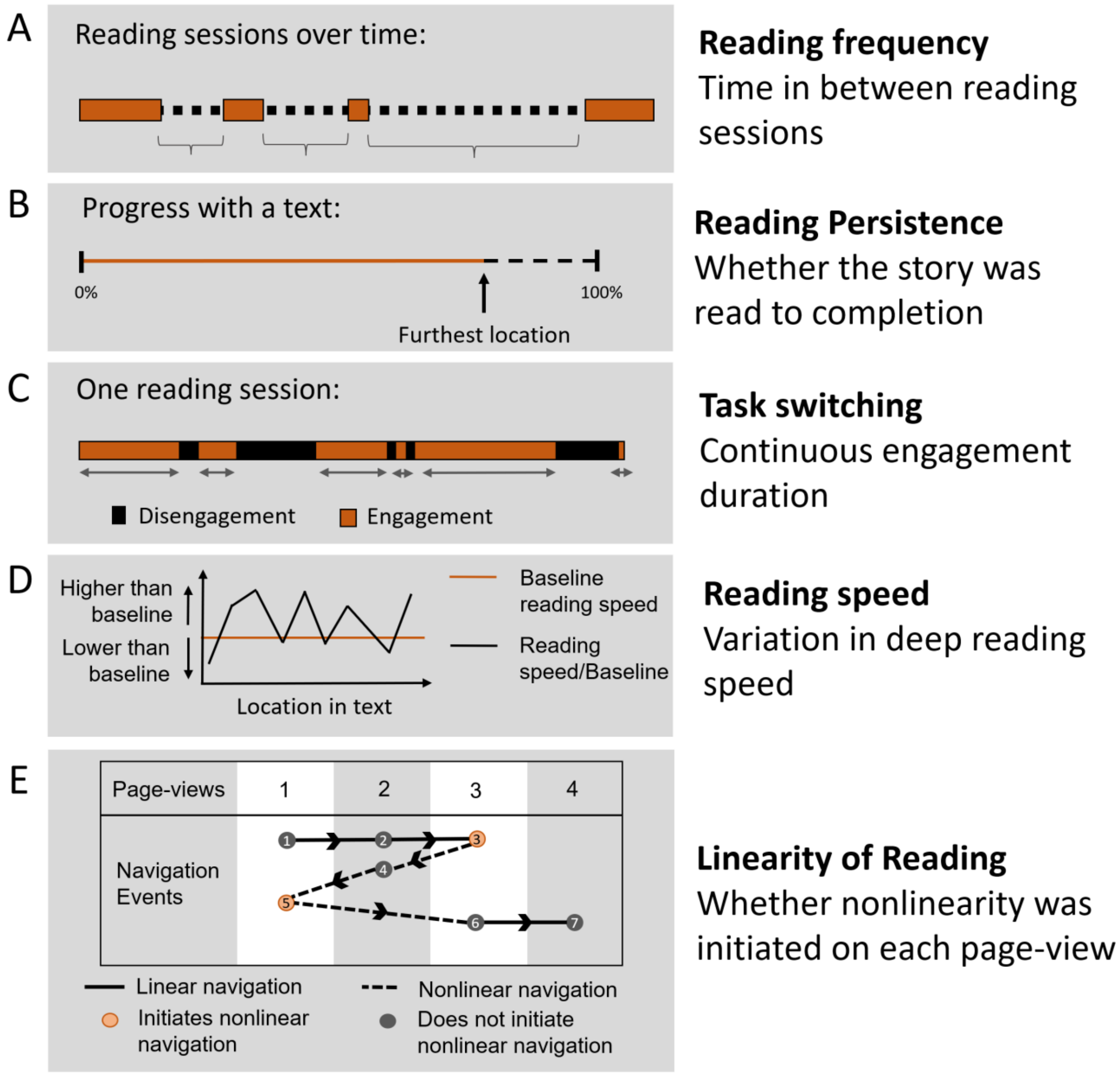
Reading persistence indicates how far in a text a participant has read, and therefore, it could only be measured once for each text-participant pair. The measurement varied across the different studies; however, the main intention of the measure was to approximate how close to finishing the text the participants came (see Figure 3.6 B).

Task-switching frequency refers to the number of disengagements during a reading session. To capture variance in how often participants disengaged from the text, we avoided using a simple count of disengagements as the measure, and instead, we computed participants' continuous engagement duration. This measure indicates for how long participants engaged with the text before disengaging from it (see Figure 3.6 C). Frequent task-switching is therefore indicated by short continuous engagement durations, whereas long continuous engagement durations show that a participant focused on the text for extended periods without task-switching.

To account for individual variation in participants' reading speed, we used the baseline reading speed result as the benchmark for variation in studies reported in Chapters 4 and 5. We were primarily focused on variance in participants' deep reading speeds, and therefore, we assessed how participants' deep reading speed on each page-view varied from their baseline (see Figure 3.6 D). Due to the coarse nature of the Amazon Kindle user data, information on participants' reading speed or linearity was not available in Chapter 6.

Figure 3.6

Illustrations of the Reading Behaviour Measures



Note. A) Reading frequency was measured by time in between reading sessions, indicated by the square brackets. B) Reading persistence was measured by participants' progress in reading the text. C) Continuous engagement duration within reading sessions was used as a measure of task-switching frequency, indicated by the length of the arrows in the illustration. D) Reading speed was captured by assessing variation in participants' deep reading speed in relation to their baseline speed. E) Frequency of nonlinear navigation was estimated by assessing whether each page-view initiated nonlinear navigation or not (indicated by the orange circles).

In terms of linearity of reading, we were interested in how frequently participants used nonlinear navigation during reading of a text. To measure this, we assessed on which page-views participants initiated new nonlinear navigation (see Figure 3.6 E). We focused on initiation of nonlinearity to avoid counting nonlinear navigation events more than once. This was done because participants frequently navigated texts nonlinearly by rapidly turning pages to reach their preferred location in text, and therefore, a simple binary assessment of whether a page-view included nonlinear navigation or not would have resulted in a single navigation block counted multiple times. Initiation of nonlinear navigation was defined as any nonlinear navigation that (1) follows a linear or a non-navigation event, (2) or which follows a nonlinear navigation event that is either executed to a different direction than the previous, or with a different method (e.g., by turning pages forwards when the previous event included a forward leap using the progress bar).

3.3.4 Questionnaires

Questionnaires were used to capture participants' reading motivation, electronic reading experience, and demographics.

3.3.4.1 Surveys on Motivation

Our aim was to measure reading motivation on both the contextual and situational levels, in accordance to the Self-determination Theory (SDT) by Deci and Ryan (1985) and the hierarchical model of motivation by Vallerand (2000; see Figures 2.1 and 2.2 in Chapter 2). Motivation was measured, therefore, by two different questionnaires. At the beginning of the studies, participants responded to Intrinsic Motivation Inventory in Reading (IMI-R), developed by Frijters (2004) to measure contextual reading motivation in children. The IMI-R is an adjusted version of a situational motivation questionnaire, the Intrinsic Motivation Inventory (IMI) by Deci and Ryan (1990). IMI-R includes 20 items asking participants to rate their interest towards reading as an activity, their perceived competence in reading, and their perceived effort put in reading. Only the interest and competence subcomponents were used in analyses. The ratings are done on a 7-point Likert scale ranging from "not at all true of me" to "very true of me". Frijters (2004) found a high internal consistency ($\alpha = .89$) for the IMI-R.

The wording in the IMI-R was modified to allow usage with adults. In all items, 'reading stories' was changed into 'recreational reading' (e.g. *I like reading stories* was changed into *I like recreational reading*), and item 11 *"I think I read stories well, compared to other kids"* was changed into *"I think I read well, in comparison to others"* (see Appendix A for the questionnaire). Items in each subcomponent (interest, competence) were summed to capture the subcomponent score.

Participants responded to IMI after completing the reading phase of the study (see Appendix A for the questionnaire). IMI is a widely used questionnaire inspired by SDT, and its usage has been tested extensively (Leng et al., 2010). The full questionnaire consists of 45 items measured on a 7-point Likert scale ranging from "not at all true of me" to "very true of me", however, the questionnaire is rarely used in full (Markland & Hardy, 1997). We used 21 items from IMI to measure participants' situational motivation by assessing their interest in their selected text, perceived competence, and autonomy. Whereas autonomy and competence refer to the basic needs of autonomous motivation, the subcomponent of interest is thought to represent intrinsic motivation (Center for Self-determination Theory, n.d.) and as such it is considered to represent participants' situational motivation.

The full IMI scale includes a subcomponent of 'relatedness' in addition to competence and autonomy. However, the items on relatedness do not adapt well to activities that are not inherently social. For example, the items "I felt like I could really trust this person" and "It is likely that this person and I could become friends if we interacted a lot" are difficult to adapt to a reading activity that does not include teamwork. As a result, only competence and autonomy could be measured in the studies.

Although IMI has been rigorously tested, it is not a commonly used questionnaire for measuring reading motivation. According to findings by Conradi et al. (2014), the Motivations for Reading Questionnaire (MRQ) by Guthrie and Wigfield is one of the most popular reading motivation scales with 29% of previous work utilising it. The scale was developed in accordance with the reading engagement model theory to measure children's reading motivation (Wigfield & Guthrie, 1997). Schutte and Malouff (2007) modified MRQ for use in adults by developing the Adult Reading Motivation scale.

We decided to use IMI instead of other options because of its foundation in SDT. In line with our theoretical framework described in Chapter 2, we expected that SDT with the extension of Vallerand (2000)'s hierarchical model of motivation would provide a comprehensive understanding of participants' reading motivation. IMI allowed us to measure motivation on the situational level, however, with the addition of IMI-R, we were able to study motivation contextually as well. In contrast, MRQ and the Adult reading scale focus on measuring motivation on the contextual level only.

3.3.4.2 Surveys on Electronic Reading Experience

As described in Chapter 2, few previous studies have assessed adults' electronic reading experience. The majority of studies have been conducted in the area of human-computer interaction (HCI), and they are concerned with the reasons why a reader would select an electronic reading platform (e.g., Hsiao & Chen, 2017; Yoo & Roh, 2019), instead of the individuals' skills using these reading formats. Other studies have used self-developed items to measure participants' reading format preferences (e.g., Loh & Sun, 2022; Mizrachi, 2015). As our focus on task-relevant electronic reading experience (TR-EEXP) goes beyond these previous approaches, we developed a new scale for the purposes of this research project.

The survey included 21 items measuring participants' frequency of using different devices for various reading purposes on a 5-point Likert scale (from 'Never' to 'Every day', see Appendix A for the questionnaire). TR-EEXP was measured by two variables that indicated the participants' frequency of engaging in reading tasks similar to the one completed during the studies. The first indicated participants' frequency of reading task-relevant text types on electronic devices. Relevant text types were assumed to be fictional, narrative, long-form texts, such as books and short stories, and therefore, the measure was created by summing responses to two items, *"how often do you read fiction books electronically?"* and *"how often do you read short stories or fanfiction electronically?"*. The second measure reflected the participants' frequency of using task-relevant digital devices for recreational reading. Task-relevant devices were considered to be any devices that could be used to read a text in the studies. In Chapters 4 and 5, task-relevant devices included smartphones, tablet computers, laptops, and PCs, as these digital devices could be used to access the e-reader system. In addition to these devices, Amazon Kindle could be used on dedicated e-ink devices in Chapter 6. Items indicating the participants' frequency of reading on these devices were summed together. A combination of these two measures was expected to be indicative of TR-EEXP. In addition to the frequency items, the questionnaire included an item asking participants to report which digital devices they had access to.

3.3.4.3 Questionnaire Timings

Across the three studies, questionnaires on demographics and contextual reading motivation were included in the beginning of the study, before the reading phase, whereas situational motivation and electronic reading experience were assessed after the reading phase. This structure was decided on to avoid burdening the participants with long surveys at any one time.

Due to their similarity, it was important that the motivation questionnaires were responded to at different time points. The situational motivation questionnaire (IMI) required the participants had completed the reading phase, and therefore, it was used as a post-experimental survey whereas the contextual motivation questionnaire (IMI-R) was included at the beginning of the study.

Information about participant demographics, such as age, gender, highest education level achieved, and native language, was assessed at the beginning of the study. This was important to allow assessment on whether drop-out rates were connected to any demographic variables. To avoid overburdening participants at the beginning of the study, the electronic reading experience questionnaire was included at the post-experimental survey stage.

3.3.5 Data Analysis Approach

Our aim was to study how much variance in reading behaviour could be explained by reading motivation, TR-EEXP, and task-context. To this end, we used multilevel models (MLMs, also known as “mixed models”) to analyse reading behaviour. MLMs are an application of regression analysis, with functionality to control for nonindependence of observations (Barr, 2013; Singmann & Kellen, 2019). MLMs made it possible to measure the relationship between reader characteristics, task-contexts and reading behaviour while controlling for variation in *random effects*. Random effects are used to estimate variation among units, such as within-participants or experimental blocks (Barr, 2013), which is useful for improving the accuracy and generalisability of the results (Barr, 2013; Singmann & Kellen, 2019). Random effects made it possible for us to control for individual differences and random variation within books read, but more importantly, using MLMs allowed us to capture the dependencies in our data: apart from the measure of persistence, participants had multiple data points in reading behaviour measures, and the same texts were read by multiple participants. Relying on traditional regression analyses would have therefore violated these tests' assumption of independence and resulted in an inflated Type I error rate (false rejection of the null hypothesis, aka. a false positive result; Singmann & Kellen, 2019), whereas averaging the reading behaviour measures for regression analyses would have resulted in significant loss of nuance in the data (Wiley & Rapp, 2019).

Traditionally, MLMs include random effects to measure variation among participants and different items used in an experimental study. As a result, a *linear mixed model* with a continuous outcome variable may take the following form for *S* subjects and *I* items (the equation is adapted from Barr, 2013):

$$Y_{si} = \beta_0 + S_{0s} + I_{0i} + (\beta_1 + S_{1s})X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + e_{si}$$

In which Y_{si} describes the outcome variable in the model and β_0 indicates the intercept. Fixed effects are the predictors of interest in the model, reflected by $\beta_1 X_1$-$\beta_n X_n$ in the formula.

Random effects can be added in the model as intercepts or intercepts with slopes. The former can be used to vary the intercept term (β_0), whereas the latter is used to improve estimates of fixed effects (Barr, 2013). In the equation, random effect intercepts are indicated by S_{0s} and I_{0i}, and random effect slopes are specified in relation to each fixed effect, for example in the case of $(\beta_1 + S_{1s})X_1$. Finally, e_{si} in the equation describes the residual error term in the model.

Categorical outcome variables can also be estimated with MLMs. These data types call for use of generalised linear mixed models which act similarly to logarithmic regression analyses, with the addition of random effects (Wang et al., 2022). Accordingly, the model effects are estimated by log-odds instead of the original scale used in the outcome variable (Wang et al., 2022). In this thesis, we used both linear mixed models and generalised linear mixed models depending on the distribution of the outcome variable.

Data were analysed in R with the lme4 package from Bates et al. (2015). From here on, we use syntax from lme4 to describe the models in an effort to improve readability. In the syntax, fixed effects are denoted by the name of the predictor variable (e.g., "Condition" instead of $\beta_1 Condition_1$), whereas random effects are expressed by "(1 | Random effect variable)" for intercept-only random effects, and by "(1 + Slope variable | Random effect variable)" for random effects with slopes.

Multilevel models can be powerful tools for analysing complex data that need to be controlled for a variety of confounds, such as the datasets collected in this thesis. However, the potential of MLMs is dependent on the ways in which the model is structured and how the structure is selected (Harrison et al., 2018). A simulation study by (Barr, 2013) showed that *theoretically maximal* models are most reliable for evaluating effects in confirmatory hypothesis testing using MLMs. According to (Barr, 2013), these models include all variables of theoretical interest as fixed effects to assess their connection with the outcome variable. Furthermore, the model can include control variables as fixed effects to account for the influence of any potential confounds in the results. Random effects should cover all dependencies in the data: any non-independent units, such as a text read by multiple different participants, can be controlled for by allowing group averages to vary (Harrison et al., 2018). In addition to these random intercepts, (Barr, 2013) argues that a theoretically maximal model should include random slopes for each variable of theoretical interest. These slopes can improve our estimates of fixed effects, which is key for reducing the Type I error rate (Barr, 2013). According to (Barr, 2013), the highest-order slopes should be included, and thus, if a hypothesis is dependent on an interaction effect, the interaction should be included as a random slope in the model. As random effects can only be estimated for repeated observations, the slopes can only be included for random variables that have more than one observation for each level of the slope variable.

Although maximal models are considered to the be the gold standard in multilevel modelling, they are not always possible to implement. Complex MLM structures are liable for nonconvergence issues, where the model fails to find an adequate solution based on the available data (Barr, 2013). Furthermore, a high level of complexity can result in singular fits which indicates of issues in estimating the random effect variance (Bolker, 2023). The issue can arise from an overly complicated random effect structure or general over-parameterisation (i.e., too many fixed and random effects compared to the available data; Barr, 2013; Harrison et al., 2018). To avoid the latter, we aimed to only specify models in which $(n_{obs}/k) > 10$ where n_{obs} stands for the number of observations in a model, and k indicates the overall number of parameters in a model structure, in accordance with suggestions by Harrison et al. (2018). Overall non-convergence and singularity issues, on the other hand, were mitigated by making sure that the number of observations in the model exceeded or equalled the amount of random effect groups multiplied by the number of random effect parameters ($n_{obs} >= n_{REgroups} * k_{REparameters}$), as instructed by Wiley and Rapp (2019). Therefore, random slopes were not added to a random intercept of text indicator if the number of different texts used ($n_{REgroups}$) multiplied with the random effect parameters of text indicator ($k_{REparameters}$) exceeded the number of observations evaluated.

Avoiding the overfitting of models with too complex model structures allowed us to avert some convergence issues, but it did not eliminate the problem. Indeed, nonconvergence and singular fits are a common issue in multilevel modelling (Bolker, 2023), which can be due to a variety of different reasons. In these cases, we aimed to simplify the model structure in a principled way, in accordance with suggestions by Barr (2013).

In the following sections we will introduce the two models used, first the model of reader characteristics and then the model of task-contexts. These MLMs were used for different aims, the former to address our hypotheses on the connection between reading behaviour, motivation, and TR-EEXP, whereas the latter was used to explore how reading behaviour was connected to the task-context. Accordingly, the models differed in the fixed effects and random effects included, and different model selection methods were used to best address our aims for each type of MLM. See Table 3.1 for a summary of the two models.

3.3.5.1 The Reader Characteristics Model

The first model was used to assess how much variance in participants' reading behaviour could be accounted for by *reader characteristics*. The key variables in the model were situational and contextual motivation and TR-EEXP, but the predictors also included variables to account for the effect of possible confounding variables. In addition to measures of motivation, the model included predictors reflective of the basic needs of competence and autonomy. No information about 'relatedness' could be gathered with the questionnaires used for the study, and so it could not be included in analyses despite of its important role as a basic need of autonomous motivation (Deci & Ryan, 2000). Information about participants' demographics, such as age, level of education, gender, and native language, was included to account for differences between participants. Furthermore, the model included a predictor to account for changes between different devices and text layouts. A study by Moustafa (2016) showed that the device size and text layout can affect the reader's engagement, which could be reflected in our reading behaviour observations. Finally, information about the experimental phase was included in studies described in Chapters 4 and 5 to account for the possibility that participants' reading behaviour was affected by the increasing pressure to finish reading the text in time.

Two-way interactions were included when needed to address our hypotheses. The two TR-EEXP measures were allowed to interact to test our hypotheses on the measures' combined effect. Furthermore, where necessary, interactions were included for motivation variables and situational competence to assess whether motivation was associated with reading behaviour in connection to text difficulty (see hypotheses in Chapter 2). To avoid overfitting the model, we aimed to use only two-way interactions in the models. Three-way interactions were only included if they were required to address our hypotheses.

We aimed to use a theoretically maximal random effect structure in the reader characteristics model, as suggested by Barr (2013). Accordingly, reader characteristics models included a random intercept for each participant and text, to account for the repeated nature of these variables in our sample. In Chapters 4 and 5, these random effects were explicitly nested because each participant only read one text during the study, and therefore, participant indicators acted as subgroups of text indicators in our data. Although nested random effects are usually indicated by '(1 | Variable 1 / Variable 2)', in the reader characteristics model we instead specified random effects separately to allow us to use different random slopes for participant and text indicators.

In accordance with Barr (2013), random slopes were included in correspondence to our hypotheses, and thus, variables measuring situational and contextual motivation and TR-EEXP were used as random slopes. However, the slopes were only included for the random effect of text indicator. Random slopes could not be included for the participant indicator because motivation and TR-EEXP were only measured once for each participant in each of the studies. As mentioned earlier, to model a random slope, it is necessary to have multiple values in both the outcome and the predictor variable for each unit of the random effect (Barr, 2013). As a result, the maximal random effect structure for the reader characteristics model did not include any slopes for the random effect of participant indicator.

In summary, the reader characteristics MLMs took the following form[6] (see Table 3.1 for more information):

[6] The structure of the reader characteristics model varied slightly between studies and the different reading behaviours measured.

Reading behaviour ~ Device information + Reading phase information + Demographic information + Basic needs of situational motivation + Basic needs of contextual motivation + Contextual reading motivation (CMOT) + Situational reading motivation (SMOT) + TR-EEXP variables + Any necessary interaction effects + (1 + CMOT + SMOT + TR-EEXP | Text indicator) + (1 | Participant indicator)

If the maximal model structure did not reach convergence or if it was singular, the model was simplified backward stepwise manually. Backward stepwise methods of model selection have been criticised in the past (e.g., see Matuschek et al., 2017), however, we followed a precise method in backward selection to minimise any biases. First, random effects were simplified by removing the random slope that accounted for the least variance in the model. If the model did not converge or remained singular after all slopes were removed, fixed effects were removed from the model, starting with the predictor variable that contributed least to the model, according to p-values. Significant fixed effects were not removed.

All models were tested for assumptions in accordance to guidance in previous research: whereas linear mixed models were assessed for multicollinearity, influential observations, heteroscedasticity, and normality of random effects, generalised linear mixed models were tested for under- and overdispersion, multicollinearity, influential observations, heteroscedasticity, and normality of random effects. In addition to these assumptions, some researchers have argued that linear mixed models should align with the assumption of normality of residuals (Santos Nobre & da Motta Singer, 2007). However, this is a controversial topic, and for example, Gelman and Hill (2007) argue that *"the assumption of normality is barely important at all. Thus, [..] we do not recommend diagnostics of the normality of regression residuals"*. Considering that tests for normality of residuals, such as Shapiro-Wilk test, are affected by large sample sizes (D'Agostino, 1971), such as the ones used in the current research project, normality of residuals was tested to understand the dataset but not treated as an assumption of linear mixed models. Variance from model assumptions was addressed in each case separately, by adjusting the model structure, removing influential cases, or by transforming the model outcome variable.

3.3.5.2 The Task-contexts Model

A model of *task-contexts* was used to explore how variance in reading behaviour is connected to the readers' situation and environment. The predictors included variables such as location in text and timing of reading sessions that could be used to enhance our understanding of *how* adults read electronically. Whereas the reader characteristics model was used to address our hypotheses with a pre-specified model structure, task-contexts models were used primarily for exploratory purposes.

As the purpose of the model differed from the reader characteristics model, we also used a different model selection procedure. First, an additive random intercepts-only model was specified, which included predictors describing the event timing (reading session indicator and time since the beginning of the reading session), location in text, and previous events. The last was used to assess the connection between the outcome variable (reading behaviour at event k) and reading behaviour at events *k-1* and *k-2*. Additionally, the model included information on the experimental phase and device size as control variables, similarly to the reader characteristics model. Nested random intercepts of participant and text indicator were included to account for dependencies in the data.

The additive, random intercepts-only task-contexts model had the following form (see Table 3.1 for more information):

Reading behaviour ~ Device information + Reading phase information + Previous events ($Event_{k-1}$ *and* $Event_{k-2}$*) + Reading session indicator + Time in the reading session + Location in text + Reading location (Chapter 5 only) + (1 | Text indicator / Participant indicator)*

Random slopes were added to the model with the ‘best-path’ algorithm described by Barr (2013). We used this data-driven selection method to avoid overfitting the model with too many random slopes. This was not an issue in the reader characteristics model because the model fit was pre-specified to best address our hypotheses without overfitting. In best-path algorithm, addition of each predictor as a random slope was tested against the intercepts-only model using a liberal alpha-level of .20. If multiple predictors contributed to the model, the slope with the lowest p-value was added to it. This selection was then repeated for the remaining slopes.

Once the additive random slopes model was selected, it was simplified by the backward stepwise method until convergence. Two-way interactions were then added between predictors remaining in the model, and in case of non-convergence, the model was again selected backward stepwise. To avoid multicollinearity, the two predictors indicating previous events ($Event_{k-1}$ and $Event_{k-2}$) were not included in interactions with any predictors apart from each other. Once the model reached convergence, it was tested for assumptions similarly to the reader characteristics models.

Whereas the reader characteristics model was conducted for all reading behaviours, task-contexts were assessed in relation to reading frequency, task-switching, reading speed, and linearity, but not reading persistence. Considering that persistence reflects how far in the text the participant reads, the measure was expected to be confounded with many of the task-context model predictors, such as location in text or reading session number. Furthermore, persistence could only be measured once for each text-participant pair, and therefore, it was not possible to measure previous events. As a result, we decided that it was not meaningful to study task-contexts of reading persistence in this research project.

The task-context model structure was modified depending on whether inclusion of the predictor variables resulted in considerable data loss or not. In maximum likelihood MLM models estimated with the lme4 package in R any missing values in the outcome variable or predictors need to be removed (Bates et al., 2015). As a result, missing information in any of the fixed effects can result in data loss. Previous research has shown that this can be avoided by imputation of missing values (e.g., Sinharay et al., 2001). However, this was not considered to be a viable option for the current study as the missing information in previous events was a systematic feature of the type of data collected, and not random error.

In particular, this limitation had an effect on our estimations of previous reading behaviour events. This is because information on $Event_{k-1}$ and $Event_{k-2}$ is missing for each participants' first two events: if $k = 1$, we cannot measure $Event_{k-1}$ or $Event_{k-2}$, and if $k = 2$, we cannot measure $Event_{k-2}$. Therefore, including $Event_{k-1}$ and $Event_{k-2}$ as fixed effects in task-contexts models resulted in loss of each participants' first two reading behaviour observations. This was considered to be an acceptable limitation when the data loss is negligible, for example in the case of reading speed measured on each page-view of a 100-page text, where inclusion of $Event_{k-1}$ and $Event_{k-2}$ would have resulted in 2% data loss. However, the effect of previous events on higher level reading behaviour, such as reading frequency, could not be estimated: the inclusion of $Event_{k-1}$ and $Event_{k-2}$ would have resulted in the removal of participants' first two frequency measurements, and so any participants with less than four reading sessions would have been excluded from the analysis. To address this, we decided to only evaluate the effect of previous events on reading behaviour when only 10% or less of the data is lost.

Table 3.1

Summary of Reader Characteristics and Task-context Models

	Reader characteristics model	Task-context model
Purpose	Confirmatory hypothesis testing	Exploratory data analysis
Model selection process	1. Pre-specified maximal interactive model, 2. Backward selection if necessary	1. Additive intercepts-only model, 2. Additive model with random slopes, 3. Backward selection if necessary, 4. Interactive model, 5. Backward selection if necessary
Fixed effects	1. Theoretical interest: a. Situational motivation b. Contextual motivation c. Task-relevant electronic experience (TR-EEXP) d. Situational competence 2. Control variables: a. Contextual competence b. Device size c. Timing of participation d. Demographics	1. Task-context variables: a. Previous events, event k-1 and event k-2 b. Reading session number, timing in reading session c. Location in text d. Reading location (Chapter 5 only) 2. Control variables: a. Device size b. Timing of participation
Random effects	Explicitly nested to allow for different slopes: (1 | Participant indicator) + (1 + Situational motivation + Contextual motivation + TR- EEXP | Text indicator)	Nested, intercepts-only before random slope selection: (1 | Text indicator / Participant indicator)
Random slope selection	Pre-specified random slopes in text indicator random effect for variables of theoretical interest.	'Best-path' algorithm described by Barr (2013): Addition of each slope is tested against the intercepts-only model. The slope with the lowest p-value is added in the model and testing is resumed by comparing addition of other slope variables against the model with previously accepted slope.
Backward selection method	Backward selection is used if the model does not converge or if it is singular. One variable is removed at a time, until the model converges or is no longer singular. Selection order: (1) Random slopes - remove slope that accounts for the least variance in the model, (2) Fixed effects - remove the fixed effect that contributes the least to the model, according to p-values. Significant effects are not removed.	

3.4 Chapter Summary

In this chapter, we identified gaps in previous approaches to studying reading behaviour. Whereas lab-based studies have failed to capture natural reading behaviour (Kingstone et al., 2008; Mckay et al., 2021), self-reports can be biased by retrospective recall and the tendency to report socially desirable behaviour (Smith & Stahl, 1999). In this thesis, we use two novel methods to address these limitations.

The first method, an e-reader web application, was developed for the purposes of this research project. It includes a comfortable e-reading platform that participants can access via a web browser on multipurpose digital devices, such as smartphones and computers. The e-reader system has embedded tracking functions that allow us to capture users' reading behaviour on the page-level. Reading behaviour on dedicated e-ink e-readers, on the other hand, is studied using our second method based on Amazon Kindle user data. In the study, participants are asked to donate their Amazon Kindle user data to the study, which includes information on their reading sessions for up to 5 years in the past. These methodologies allow us to study reading behaviour unobtrusively, within participants' natural reading environments, bypassing the issues associated with most of previous work.

Data from the two methods were used to create measures of reading behaviour, which were then analysed in relation to reader characteristics and task-contexts. Information on the former was collected via questionnaires: whereas two versions of Intrinsic Motivation Inventory by Deci and Ryan (1990) were used to measure reading motivation in accordance with our theoretical framework outlined in Chapter 2, a self-developed survey was used measure TR-EEXP. The relationship between reader characteristics, task-contexts and reading behaviour was assessed by multilevel models. This approach allowed us to capture dependencies in our dataset, while controlling for the effect of confounding variables, such as demographic information or timing of participation.

Chapter 4

The Effect of Reading Motivation, Electronic Experience, and Task-context on Short Story Reading Behaviour

4.1 Overview

Previous research has indicated that reading behaviour is connected to both reader characteristics and the context in which the text is read. In particular, reading motivation has been suggested to be a key predictor of reading behaviour (Schiefele et al., 2012). More autonomous situational motivation, indicative of a high level of motivation towards a particular text, has been associated with high reading persistence (Brinda, 2011; Fulmer & Frijters, 2011) and frequency (Van Ammel et al., 2021), and infrequent task-switching (Faber et al., 2018; Tulis & Fulmer, 2013). Low levels of situational motivation, on the other hand, can result in passive reading engagement that can cause the reader to disregard adjusting their text navigation patterns to task demands (Maier & Richter, 2014; Milne, 2021; Rapp et al., 2007). Previous studies have shown that to comprehend a difficult text, readers need to make frequent regressions to reread difficult sections (Vitu & McConkie, 2000), and they need to slow down their reading speed to allow more time for procesing (Brysbaert, 2019). Neglecting these adjustments when the text is difficult to understand is likely to result in low comprehension (Schotter et al., 2014; Rayner et al., 2016).

According to Self-determination theory (SDT) by Deci and Ryan (1985), satisfaction of basic needs regulates quality of motivation. As described in Chapter 2, the reader needs to feel sufficiently competent and socially supported to internalise motivation for a task. However, to experience autonomous motivation, the reader also needs to experience autonomy (Deci & Ryan, 2000). Autonomy in reading refers to the possibility of choosing one's own reading materials and the ways in which reading is engaged in (Deci & Ryan, 2000).

Low autonomy in reading is common - pupils often face required reading lists as homework (Bushman, 1997), and adults tend to internalise social pressure to read acclaimed titles that would be otherwise uninteresting for them (Nell, 1988b). This is worrying because thwarting the basic need of autonomy can have a considerable impact on reading motivation. Pupils who experience low autonomy frequently can start to experience controlled motivation on the contextual level as well, which can lead them to avoid all reading-related activities (Vallerand, 2000).

As described in Chapter 3, previous research on reading behaviour has been largely limited to lab-based approaches and self-reports. Therefore, we have little knowledge of how situational motivation is associated with natural reading behaviour in the context of readers' daily lives. In this chapter, we present an experiment on sixty undergraduate students' reading behaviour using the e-reader system that was described in Chapter 3. The students read a short story on the e-reader over the course of 14 days while their reading behaviour was tracked unobtrusively.

To assess the connection between situational reading motivation and behaviour, we aimed to influence participants' situational reading motivation by manipulating their perceived autonomy. The autonomy manipulation was inspired by a previous study by Fulmer and Frijters (2011) who asked adolescents to rank descriptive titles of stories based on their interest in reading each one in full. Half of the participants were given the story that they were most interested in reading, whereas the other half were given the story of which descriptive title they rated as the least interesting. In the latter condition, being denied their expressed preference affected the participants' perceived autonomy, and as a result, they experienced less autonomous situational motivation (Fulmer & Frijters, 2011). Similarly, we asked participants to rate their interest towards reading each of nine different short stories based on their descriptive summaries. Half of the participants were given a short story that they were most interested in reading, whereas the other half received a story that they would not have picked for themselves. We set a study-specific hypothesis (H1) on the effect of our manipulation: participants in the high-autonomy condition were expected experience more autonomous situational motivation compared to the low-autonomy group. Condition was used as a measure of situational motivation in the current study if H1 was supported.

Reading behaviour was expected to be connected to participants' reader characteristics (see RQ1 in Chapter 2). We expected more autonomous situational and contextual motivation, and higher levels of task-relevant electronic reading experience (TR-EEXP) to support reading engagement. Accordingly, we expected that motivation and TR-EEXP would be connected to infrequent task-switching (H1.1c, H1.2c, and H1.3c, see Table 4.1). Furthermore, higher motivation and TR-EEXP were expected to support participants in reacting to text difficulty adaptively by slowing down their reading speed and using more frequent nonlinear navigation when the text was perceived to be difficult to read (H1.1d-H1.3d and H1.1e-H1.3e, see Table 4.1).

Similarly, task-contexts of reading were expected to have an impact on reading behaviour (see RQ2 in Chapter 2). Self-report studies have suggested that individuals may struggle to settle down to read (e.g., Rosenthal, 1995). Accordingly, we expected that the beginning of reading sessions would be connected to more frequent task-switching (H2.4a), a slower reading speed (H2.4b), and more frequent nonlinear navigation (H2.4c), when compared to the end of reading sessions (see Table 4.1). Similarly, familiarity with the writing style and the plot may influence reading behaviour (Rosenthal, 1995; Syd Field, 2005). We expected that early rather than late reading sessions and events recorded at the beginning of the story should be connected to more frequent task-switching (H2.2a and H2.3a), a slower speed (H2.2b and H2.3b), and more frequent nonlinear navigation (H2.2c and H2.3c) if the participants struggle to connect with the story when they first start reading it (see Table 4.1).

Table 4.1

Summary of Hypotheses Addressed in Chapter 4

RQ1: Reader characteristics					
	Higher reading persistence	Higher reading frequency	Lower task-switching frequency	Baseline-level and slower reading speed when situational competence is low	More frequent nonlinear navigation when situational competence is low
Situational autonomous motivation is connected to...	H1.1a	H1.1b	H1.1c	H1.1d	H1.1e
Contextual autonomous motivation is connected to...	H1.2a	H1.2b	H1.2c	H1.2d	H1.2e
Task-relevant electronic reading experience is connected to...	H1.3a	H1.3b	H1.3c	H1.3d	H1.3e
RQ2: Task-contexts					

	Higher reading frequency	Higher task-switching frequency	Baseline-level and slower reading speed	More frequent nonlinear navigation
Reading location outside of the home is connected to...	H2.1a	H2.1b	H2.1c	H2.1d
Early reading sessions are connected to...		H2.2a	H2.2b	H2.2c
Early locations in text are connected to....		H2.3a	H2.3b	H2.3c
The beginning of reading sessions is connected to...		H2.4a	H2.4b	H2.4c

Note. The highlighted cells indicate which of the hypothesis outlined in Chapter 2 could be addressed in the study reported in this chapter. In addition to these hypotheses, Chapter 4 had one study-specific hypothesis: H1 - participants in the high-autonomy condition were expected experience more autonomous situational motivation compared to the low-autonomy group.

4.2 Method

4.2.1 Participants

Sixty undergraduate students from University of Edinburgh (35 women, 24 men[7]), aged 19-30 (M = 22, SD = 2), were recruited by advertisements in a student recruitment website. 28% of participants were non-native English speakers. The study design was approved by the Ethical Committee in the School of Informatics, University of Edinburgh (reference: 2019/81073). Informed consent was obtained from all participants. Participants were reimbursed 20GBP for their time. See Appendix B for a copy of the consent form and information sheet used in this study.

4.2.2 Materials: The Questionnaires

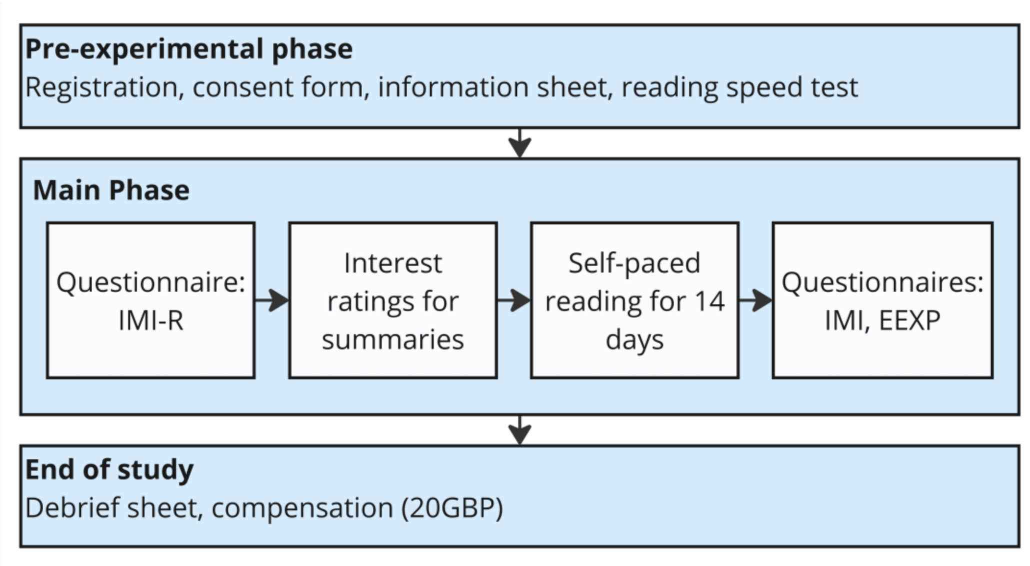
As described in Chapter 3, participants were asked to respond to three questionnaires, one at the beginning of the study and two at the end (see Figure 4.1). IMI-R and IMI were used to measure participants' contextual and situational motivation, whereas TR-EEXP was

[7] One participant preferred not to disclose their gender.

measured by a self-developed questionnaire on electronic reading experience (see Appendix A).

Figure 4.1

Procedure of the Study on Short Story Reading



The 'interest' subcomponent from IMI and IMI-R was used to measure the extent to which participants' reading motivation was autonomous. Considering that individuals' interest towards an activity gradually increases towards intrinsic motivation (Deci & Ryan, 2000), more autonomously motivated participants should score higher in the interest subcomponent (Center for Self-determination Theory, n.d.).

Additionally, subcomponents from the questionnaires were used to measure basic needs of reading motivation. From IMI, we captured participants' situational autonomy and competence scores, the latter of which reflected the participants' perception of the text difficulty. Previous studies have often measured text difficulty by objective measures such as average word length (Brysbaert, 2019), however, considering that one of our aims was to study the combined effect of reading motivation and text difficulty on text navigation (e.g. see hypotheses H1.1.d-H1.2d and H1.1e-H1.2e in Table 4.1), we only used a subjective measure of competence that relates closely with the SDT basic need of perceived competence.

Additionally, a subcomponent of competence from IMI-R was used to capture participants' perception of their reading ability. Contextual autonomy, on the other hand, could not be measured as it is not included as a component of IMI-R. IMI and IMI-R showed good internal consistency (α_{IMI}= .946, α_{IMI-R} = .901), as did the subcomponents in both scales (α = .799- .953).

Two measures were created to capture participants' TR-EEXP: (1) frequency of reading task-relevant text types on any electronic devices, and (2) frequency of using task-relevant digital devices for any type of recreational reading. For the first measure, scores were summed on two items: *"how often do you read fiction books electronically?"* and *"how often do you read short stories or fanfiction electronically?".* For the latter measure, we summed responses on four items assessing participants' frequency of using smartphones, laptops, PCs, and tablet computers for reading recreationally.

In addition to TR-EEXP and reading motivation questionnaires, individual items were used to measure participants' demographic information, memory for the story content, and feedback on the e-reader system. At the beginning of the study, we collected information on participants' age, education level, gender, and whether their native language was English. Considering that all participants were undergraduate students of a similar age, we did not use age or education level as variables in the analyses. At the end of the study, participants were asked whether they had read the short story before, and whether they encountered any issues in using the e-reader system. Lastly, participants were asked to provide a brief summary for the short story that they read during the study. The summary was included for future studies to inspect whether reader characteristics or reading behaviour were connected to memory for the text content, however, these analyses were beyond the scope of this thesis.

4.2.3 Materials: The Short Stories

Nine short stories in English were used as reading material. The stories were obtained from public domain and Creative Commons repositories[8]. The stories covered a wide range of genres to cater for the participants' interests. On average, the stories were 9333 words long (approximately 15-24 A4 pages). See Table 4.2 for more information.

In the text selection procedure, participants were asked to give ratings to short story summaries. The summaries were constructed by two annotators who after reading the stories extracted sentences from them that were descriptive of the content without giving away the

[8] All stories except one had a Creative Commons or a public domains licence. One story was mistaken to have a Creative Commons license.

plot. Sentences were extracted rather than written to make sure they accurately reflected the authors' writing style. The extracted sentences were compared, and 3-4 were selected and arranged into summaries. Summaries were then minimally edited to improve readability. The stories and summaries were assessed by five external annotators, and all were reported to accurately reflect the story content. See Appendix C for the summaries and participants' story ratings.

Table 4.2

Information on the Short Stories Used in Chapter 4

Author	Title	Publication year	Publication type	Genre	Average Word frequency (SD)	Number of unique words	Text length (words)	Number of participants
Arthur Conan Doyle	The Adventures of Sherlock Holmes: The Boscombe Valley Mystery	1891	Public Domain	Mystery	3.92 (16.81)	1,877	9,639	11
Ryk E. Spoor	Preparations and Alliances	2017	Creative Commons	Science fiction	3.83 (15.74)	2,429	11,956	10
-	-	2012	-	Fantasy	3.83 (14.29)	1,608	7,590	3
Edna Ferber	Gigolo: Not a Day over Twenty-One	1922	Public Domain	Literary fiction	3.47 (14.96)	2,335	9,790	6
H.P. Lovecraft	The Thing on the Doorstep	1937	Public Domain	Horror	3.56 (15.91)	2,408	11,012	4
Mark Twain	The Million Pound Bank Note	1893	Public Domain	Humour	3.73 (14.3)	1,656	8,398	8
Mary E. Wilkins Freeman	The Yates Pride	1912	Public Domain	Romance	4.07 (14.22)	1,458	7,253	5
Maxim Gorky	Through Russia: The Icebreaker	1910	Public Domain	Cultural fiction	3.43 (16.89)	2,376	10,353	8
Richard Connell	The Most Dangerous Game	1924	Public Domain	Action	3.32 (14.87)	1,884	8,006	5

Note. Information about one of the stories is redacted as it was mistaken to have a Creative Commons license.

4.2.4 Materials: E-reader

Participants read the short story on the e-reader system described in Chapter 3. Overall, the e-reader system was found to function well. The majority of participants (85%) indicated that they did not encounter any problems in using it. Of the participants who left feedback, five indicated that they had trouble getting used to the e-reader and they could have used further instruction, for example, on how to turn the page. Three participants indicated a preference for added functionality, such as highlighting or an in-built dictionary. Only one participant reported an issue with the e-reader system: they struggled to reset their password after forgetting it, and thus they could not log into the e-reader system on other devices than their laptop. Although this issue limited the participant's access to different devices, it did not otherwise influence their reading behaviour, and so the participant was retained in the sample.

The data collected by the e-reader system included a total of 9,199 tracking events, and on average, each participant had 153 events (*SD* = 103). The tracking data were processed according to the plan set out in Chapter 3 (see Figure 3.4 in Chapter 3). However, inspection of the data showed that alterations were needed on baseline reading speed and tracking event durations.

In the baseline reading speed test, participants were asked to read a 200-word segment of a narrative text. If the participant advanced from the reading speed test too quickly, indicating a reading speed of over 900wpm, they were asked to repeat the test with a different 200-word segment of the story. Due to a mistake, however, no lower threshold was included in the test, and so participants could pass the baseline speed test with a speed slower than deep reading. Indeed, six participants' baseline reading speed was slower than 100wpm (48.5-86.4 wpm, see Table 2.1 in Chapter 2 for the speed categories). Despite the low baseline, these participants did not use slower deep reading speeds during the study compared to the rest of the sample[9]. The inaccurate baselines were adjusted by taking an average from each participants' recorded reading speeds that fell in between 100-900wpm. After these adjustments, the average baseline reading speed in the sample was 280.4 wpm (*SD* = 127.0 wpm).

[9] A linear mixed model with a binary indicator of whether baseline speed was adjusted or not as a predictor of deep reading speed on each page-view. A random effect of participant indicator was used to control for non-independence of observations. Effect of baseline speed adjustment on deep reading speed: $b = 19.56$, $SE = 15.20$, $p = .198$.

Tracking event durations were calculated by comparing the start time of an event to that of the following event. Durations were only calculated for events that occurred within a reading session, and not for ‘closing events’, such as the participants logging out of the e-reader system or closing the browser window. This method resulted in accurate event durations because the events created a continuous record of participants’ activity on the e-reader system. However, three tracking events were found to have unrealistically long event durations due to a missing closing event. As a result, the event duration was mistakenly calculated by comparing its start time with that of the following event in a new reading session. The closing event may have been missing due to an abrupt shutting down of a computer or a failure to connect to internet. Although client-side tracking was used, the events were lost when the e-reader system was closed if they could not be sent to the server. The three events’ durations were adjusted by changing it to five minutes. This was deemed appropriate because the e-reader system would have masked the text after five minutes of inactivity.

As described in Chapter 3, all reading sessions that consisted of less than 15% engagement were identified as potential artefacts. In the current dataset, this threshold resulted in the removal of 25 reading sessions (20.5% of all sessions) from 17 participants (28.3%). Visual inspection showed that these potential artefacts varied from other reading sessions, indicating that the threshold was accurate. These potential artefacts may have occurred if the e-reader system was opened accidentally.

Due to the short length of the stories, not all reading behaviours described in Chapter 3 could be measured in the current study. The majority of the participants read the short story in one reading session (65%), and thus reading frequency could not be measured. Furthermore, all but two participants read the short story to completion, and so it was not meaningful to study reading persistence in the current study. Instead, we focused on participants’ task-switching frequency, reading speed, and linearity of reading in this study. The remaining measures are returned to in Chapter 5. See Figure 3.6 in Chapter 3 for more information on the reading behaviour measures.

More information on the tracking data and its interpretations are available in the code repository, see https://github.com/PauliinaV/Short_Story_Reading_Behaviour_Public.

4.2.5 Procedure

To participate, students contacted the experimenter and registered to use the e-reader with a personalised code. The participants were made aware that the study includes a speed test, questionnaires, and reading a short story on the e-reader within 14 days. They were told that the story would be selected according to their interest ratings for summaries. See Figure 4.1 for an overview of the procedure, and Appendix B for the information sheet.

After registration, participants completed the consent form, the baseline reading speed test, and IMI-R. Participants were then presented with the titles, authors, and summaries of nine short stories, and they were asked to rate how interested they were in reading each story in full (5-point Likert-scale ranging from *"very interested"* to *"not at all interested"*). The ratings were used to allocate participants in two conditions: in the high-autonomy condition, participants were given the story that they ranked as most interesting (n = 30), whereas in the low-autonomy condition, they were given the least interesting story according to their ratings (n = 30). After text selection, participants could access the e-reader. A pop-up window informed participants which story was selected for them, but no information was included on why they received this text. Automatic reminder emails to complete the study were sent seven days, two days, and 24 hours before the end of the reading phase.

Participants responded to IMI and the electronic experience questionnaire once the 14 days had passed, or earlier if they indicated from the e-reader menu that they had finished the reading task. Once the participant had responded to the questionnaires, they were thanked, compensated, and debriefed.

4.2.6 Design

This study had a between-subjects design. The independent variables included the autonomy condition, contextual reading motivation, and TR-EEXP. The dependent variables were measures of reading behaviour; task-switching, reading speed, and linearity of reading. See Figure 3.6 in Chapter 3 for information on the reading behaviour measures.

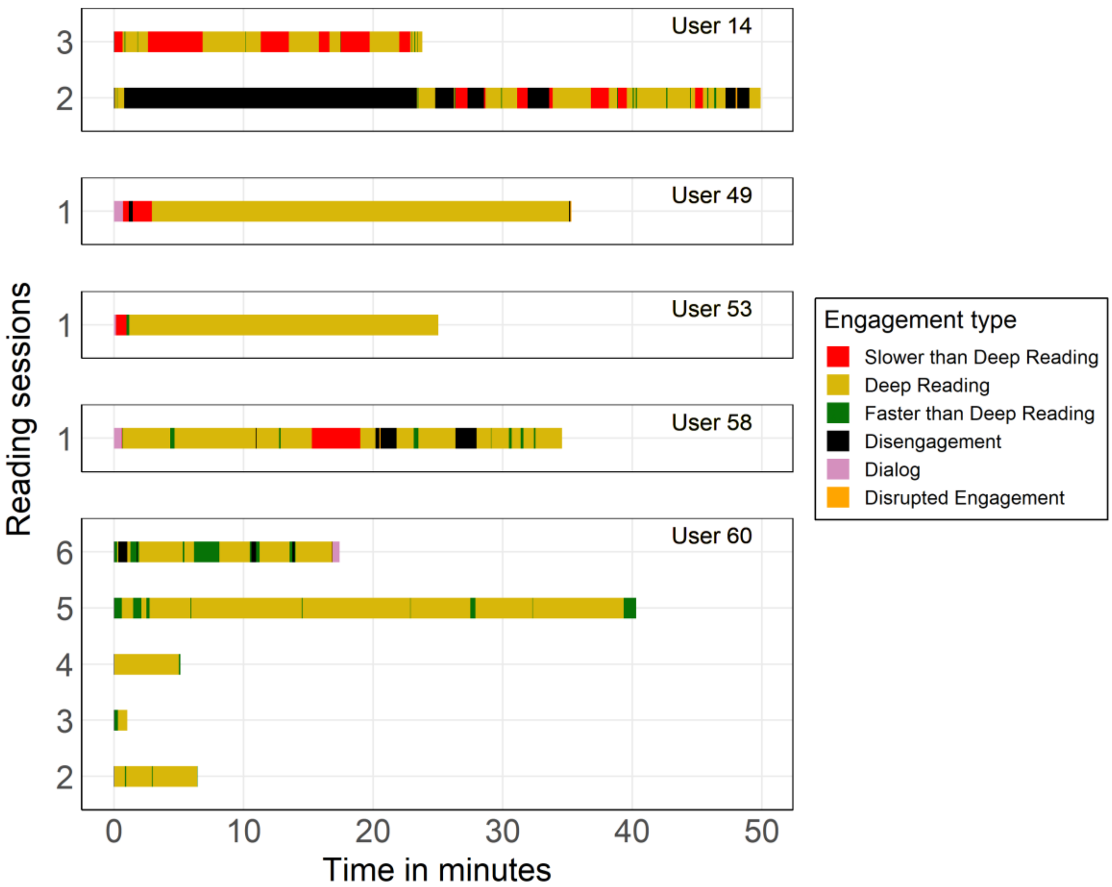
4.3 Results

In total, participants used the e-reader for 13.2-126.3 minutes (M = 50.5 mins, SD = 28.3 mins). 65% of the participants read the story in one reading session, whereas the remaining 21 participants read the story in 2-5 reading sessions. Each reading session lasted on average

38 minutes (*SD* = 32.6 mins, *range* = 1 -141.8 mins), with considerable variance in the contents of the reading sessions (see Figure 4.2).

Figure 4.2

Five Randomly Selected Participants' Reading Session Timelines



Note. The y-axis indicates the reading session number whereas the x-axis shows time since the beginning of the session. The colours refer to different engagement types. 'Dialog' engagement type indicates that the participant was viewing the menu or the information sheet. Where the reading session indicators are not consecutive, reading sessions that were identified as artefacts have been removed.

4.3.1 Reading Motivation and Condition Manipulation

Findings from IMI-R showed that the participants were somewhat interested in reading as an activity (see Table 4.3). The participants indicated that they had read, on average, 7-15 books for leisure in the past year, and that they engage in recreational reading a few times a month. Recreational reading frequency and number of books read in the past year were significantly correlated with participants' contextual motivation, $r = .415 - .567$, $p < .001$. In contrast, no connection was found between contextual motivation and frequency of reading as part of work or study, $r = -.034$, $p = .794$.

We manipulated participants' autonomy in text selection to influence their situational motivation. The manipulation was successful as participants in the high-autonomy condition reported feeling more autonomous than participants in the low-autonomy group, t(57.49) = 2.203, $p = .032$. Our hypothesis H1 was supported as participants in the high-autonomy condition experienced more autonomous situational motivation compared to the low-autonomy group, $t(49.66) = 2.225$, $p = .031$ (see Table 4.3). These differences were not due to participants' contextual motivation as participants in the two conditions did not differ in contextual interest scores, $t(55.14) = 1.181$, $p = .243$.

4.3.2 Electronic Reading Experience

The participants indicated that they own, on average, two digital devices (most often a laptop and a smartphone). These devices were rarely used for narrative electronic reading ($M_{laptop} = 2.6$, $SD_{laptop} = 1.3$, $M_{smartphone} = 3.0$, $SD_{smartphone} = 1.4$, corresponding to 'a few times a month'), and instead, participants reported reading print books most often for pleasure ($M = 3.3$, $SD = 1.2$). Narrative texts were read on digital devices only 'a few times a year' ($M_{books} = 2.0$, $SD_{books} = 1.0$, $M_{stories} = 1.9$, $SD_{stories} = 1.0$), and the most frequently read electronic text types included newspaper articles ($M = 3.7$, $SD = 1.3$), academic journals ($M = 3.6$, $SD = .9$), and textbooks ($M = 3.2$, $SD = .9$). Indeed, while the participants were somewhat experienced in using digital devices for reading expository texts, few had TR-EEXP from e-reading narrative texts on task-relevant digital devices (see Table 4.3).

Table 4.3

Descriptive Results on Questionnaires and Reading Behaviour Measures in Chapter 4

	Min-Max	Full sample	High-autonomy Condition	Low-autonomy Condition
		Mean (SD)		
Situational motivation				
Interest	1-7	4.92 (1.52)	5.34 (1.13)	4.50 (1.74)
Competence	1-7	5.01 (1.08)	5.24 (.96)	4.77 (1.15)
Autonomy	1-7	4.81 (1.34)	5.18 (1.24)	4.44 (1.36)
Contextual motivation				
Interest	1-7	5.35 (.96)	5.50 (.84)	5.20 (1.06)
Competence	1-7	4.97 (.90)	5.14 (.80)	4.81 (.98)
Electronic reading experience				
Task-relevant text types	1-5	1.93 (.83)	2.00 (.86)	1.85 (.80)
Task-relevant digital devices	1-5	2.09 (.84)	1.83 (.69)	2.35 (.90)
Reading behaviour				
Task-switching: Continuous engagement duration (min)	.28-106.50	11.58 (14.18)	10.17 (11.36)	13.07 (16.57)
Speed: Reading rate (speed/baseline speed)	.14-2.39	1.12 (.38)	1.18 (.37)	1.04 (.38)
Linearity: Proportion of events initiating nonlinearity (%)	0-26.88	9.66 (7.16)	9.08 (6.38)	10.24 (7.92)

4.3.3 Reading Behaviour

All three reading behaviours were analysed by two different models. Whereas the reader characteristics model was used to study the connection between behaviour, reading motivation, and TR-EEXP, the task-contexts model allowed us to study how variance in reading behaviour was associated with the context in which the text was read.

See more information on each models' structure and our overall model selection approach in Appendix D and Table 3.6 in Chapter 3, respectively.

4.3.3.1 Task-switching Frequency

Continuous engagement duration was used as a measure of task-switching frequency (see Figure 3.6 in Chapter 3). Therefore, longer continuous engagements reflected infrequent task-switching, whereas short continuous engagement durations indicated the opposite. In total, the participants had 1-21 continuous engagement blocks during the study (M = 4.2, SD = 3.7), and on average, continuous engagement lasted only for 11.6 minutes (see Table 2 and Figure 4.3 A).

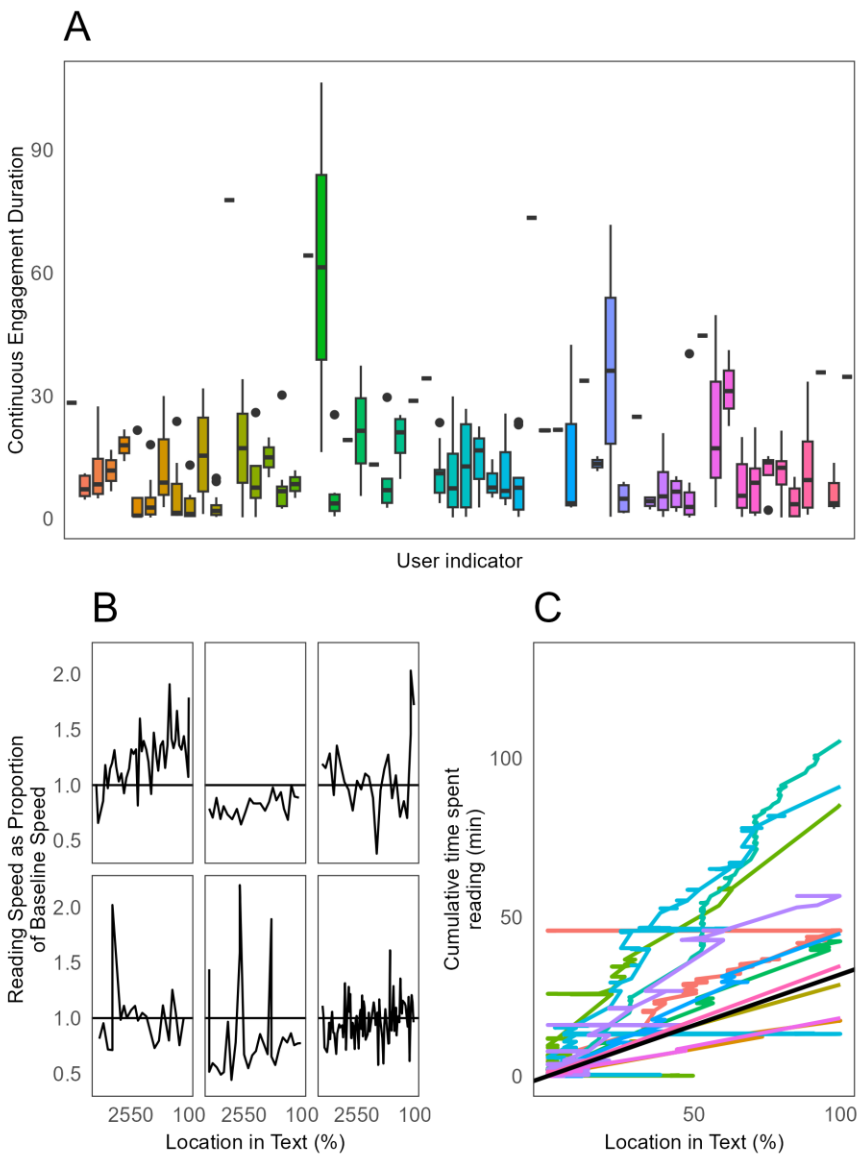
Participants in the high-autonomy condition were expected to task-switch infrequently compared to the low-autonomy group (H1.1c). However, this hypothesis was not supported as autonomy condition was not a significant predictor in the reader characteristics model (see Table 4.4). In contrast, contextual motivation, indicating of participants' interest in reading as an activity, was a significant, positive predictor of continuous engagement duration, supporting our hypothesis H1.2c (see Table 4.4). The finding showed that participants with more autonomous contextual motivation task-switched less often compared to participants with more controlled contextual motivation.

Similarly, TR-EEXP was expected to be connected to task-switching frequency (H1.3c). However, contrary to our expectations, an interaction between the two electronic experience measures was not a significant predictor of continuous engagement duration (see Table 4.4), indicating that task-relevant experience did not influence participants' task-switching frequency.

Finally, participants' task-switching frequency was found to be significantly connected to contextual and situational competence in the reader characteristics model (see Table 4.4). The result showed that participants who found the story easier to read task-switched less often than participants who found the task more difficult. In contrast, contextual competence, indicating of participants' perception of their reading ability, was negatively associated with continuous engagement duration: participants who reported a higher reading ability task-switched more often compared to participants with lower competence scores.

Figure 4.3

Variance in the Three Reading Behaviour Measures



Note. (A) Variance between participants in their continuous engagement duration which was used as a measure of task-switching frequency. To inspect the content of participants' reading sessions, see Figure 4.2. (B) Variance in six randomly selected participants' reading speed in relation to their baseline. The horizontal line indicates the participant's baseline speed. (C) Eleven participants' reading process during reading of *The Adventures of Sherlock Holmes: The Boscombe Valley Mystery* by Arthur Conan Doyle. The diagonal black line indicates what a chronological reading process at a steady speed of 260wpm would have looked like. Nonlinear navigation is indicated by horizontal lines, whereas the slopes of the lines show the participants' reading speed.

In addition to reading behaviour, we expected participants' task-switching frequency to be connected to the timing of reading sessions and locations in text. However, our hypotheses H2.2a, H2.3a, and H2.4a were not supported as reading session number, location in text, or time since the beginning of the reading session were not significant predictors in the model.

Instead, findings from the task-contexts model showed that participants' task-switching frequency was connected to the story they read, how close to the end of the study they were, and previous events (see Table 4.5). The first finding was the result of the story indicator being fit as a fixed rather than a random effect in the model (see Appendix D for more information). As a random effect, story indicator accounted for zero variance in the model – a situation that occasionally rises with intercept-only random effects when the random variance can be fully accounted for by fixed effects and residual term (Bolker, 2023). In accordance with instructions from Labudde described in Bolker (2023), we fit the model with story indicator as a fixed effect instead. The finding showed that Richard Connell's story called *The Most Dangerous Game* involved significantly higher continuous engagement durations compared to the average of the other stories. Therefore, participants task-switched infrequently while reading this action short story. A significant effect of the study phase, on the other hand, indicated that participants engaged continuously for longer periods of time towards the end of the study.

Lastly, the findings showed that $Event_{k-1}$ and an interaction between $Event_{k-1}$ and $Event_{k-2}$ were significant predictors of task-switching frequency at $Event_k$ (the outcome variable). The former result showed that a short continuous engagement duration at $Event_{k-1}$ was predictive of a longer continuous engagement at $Event_k$, suggesting that readers alternated between longer and shorter engagements. The interaction effect showed that this alternation was most likely following a short continuous engagement at $Event_{k-2}$. In contrast, a longer continuous engagement at $Event_{k-2}$ was positively associated with continuous engagement duration at Events k-1 and k. Overall, this indicates that participants either used long continuous engagement durations consistently or moved between short and long continuous engagements.

Table 4.4

Reader Characteristics Model Results in Chapter 4

	Task-switching		Reading Speed		Linearity of Reading	
	b	*SE*	*b*	*SE*	*b*	*SE*
Fixed effect						
Intercept	2.071***	.109	1.080***	.044	-1.837***	.087
Window width	-.080	.098	.013	.028	.123	.090
Days until reading deadline	-.065	.091	-.036	.019	-.006	.072
English as a native language (binary)	.283	.205	-.074	.067	.063	.174
Autonomy condition	.196	.203	-.133	.068	.190	.165
Situational competence (SCOMP)	.252*	.111	-.045	.038	.024	.094
Contextual interest (CINT)	.266*	.127	-.013	.035	-.068	.090
Contextual competence	-.369*	.137	.096*	.045	-.020	.103
TR-EEXP1: Task-relevant text types	.002	.112	-.018	.038	.023	.090
TR-EEXP2: Task-relevant digital devices	-.036	.110	-.026	.039	-.104	.098
TR-EEXP1 x TR-EEXP2	.112	.106	.027	.032	-.343***	.088
Condition x SCOMP			-.005	.060	.098	.154
CINT x SCOMP			.060*	.028	-.082	.076
TR-EEXP1 x TR-EEXP2 x SCOMP			.073*	.030	-.077	.093
Random effect	*Variance*	*SD*	*Variance*	*SD*	*Variance*	*SD*
Subject indicator	.188	.433	.040	.040	.131	.361
Short story indicator	.008	.090	.005	.005	*NC*	*NC*

Note. Continuous variables have been centered around the mean, and categorical predictors were given Helmert contrasts. Random slope variables were removed by backward selection from all three models, and so they are not included. See Appendix D tables D1, D2, and D3 for detailed information about the models. *NC* = removed from the model due to non-convergence, *b* = coefficient, *SE* = standard error, *SD* = standard deviation, '*': $p < .05$, '***': $p < .001$.

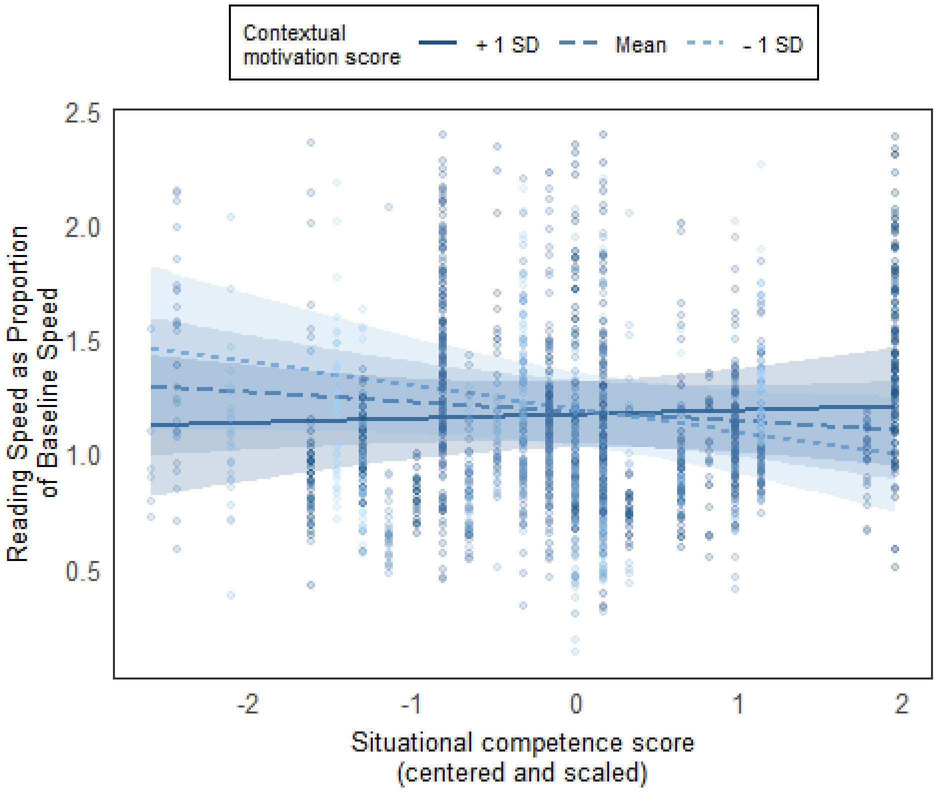
4.3.3.2 Reading Speed

Participants spent most of their time in the e-reader deep reading the short story (82%, see Figure 4.2). Variance in deep reading was measured by reading rate, which indicated how speed varied on each page view relative to baseline speed (speed/baseline speed, see Figure 3.6 in Chapter 3). Therefore, the measure shows the magnitude and the direction of variance in deep reading as a proportion of each participants' baseline speed. Indeed, participants varied considerably in their deep reading speeds (see Figure 4.3 B).

A model of reader characteristics was used to assess the connection between participants' reading speed, motivation, and TR-EEXP. Participants in the high-autonomy condition were expected to use baseline-level and slower reading speeds when the task was perceived to be difficult (H1.1d). However, this hypothesis was not supported as an interaction between condition and situational competence was not a significant predictor of reading speed (see Table 4.4). Furthermore, autonomous contextual motivation was expected to be connected to slower reading speeds when the text was difficult (H1.2d). The findings supported this hypothesis as an interaction between situational competence and contextual motivation was a significant predictor of reading speed (see Table 4.4). The result showed that more autonomously contextually motivated readers used slower reading speeds when the text was difficult to read, and faster speeds when the text was perceived to be easy (see Figure 4.4). In contrast, participants with a lower score in contextual motivation used higher than baseline-level reading speeds when the text was perceived to be difficult to read, and slower reading speeds when the text was reported to be easy.

Figure 4.4

The Effect of Contextual Motivation and Situational Competence on Reading Speed

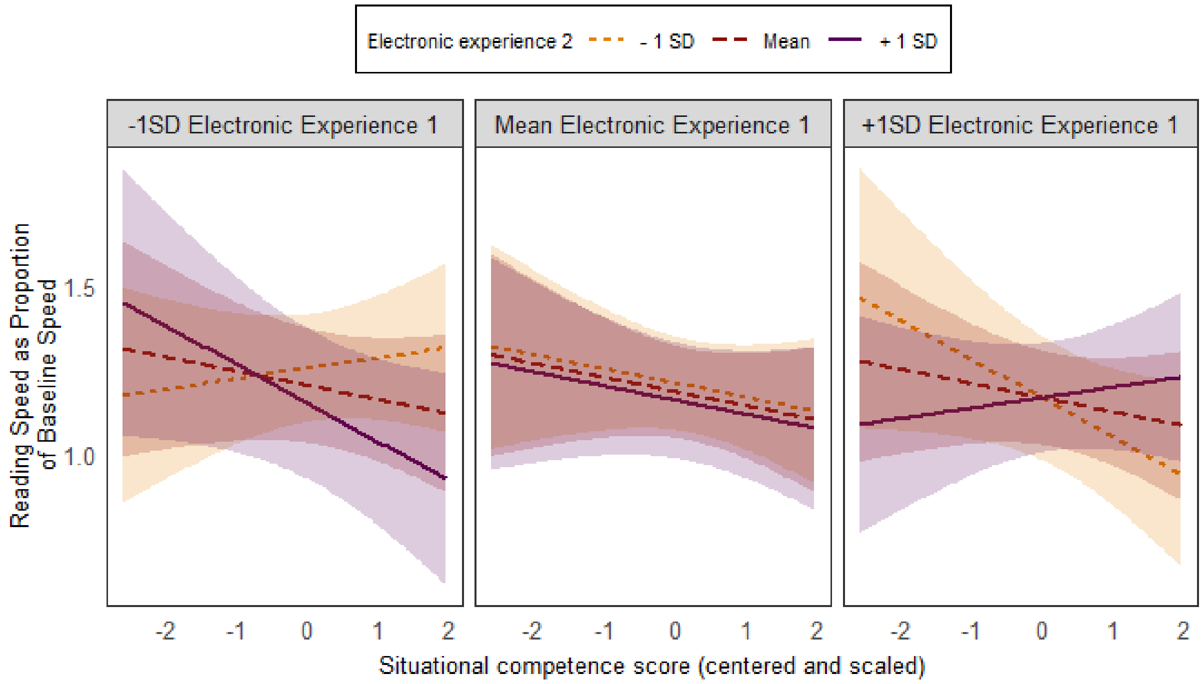


Note. The points represent observed values whereas the lines show the model fit. Contextual motivation is measured by contextual interest from IMI-R, and reading speed is measured by reading rate which indicates reading speed on each page-view divided by baseline speed. The predictors were centered around the mean and scaled.

Similarly, TR-EEXP was expected to be associated with slower reading speeds when the text was difficult to read (H1.3d). Indeed, an interaction between the two electronic reading experience measures and situational competence was a significant predictor in the model (see Table 4.4). The effect showed that participants with task-relevant experience used slower reading speeds when the text was difficult to comprehend, and faster reading speeds when the text was perceived to be easy (see Figure 4.5). In contrast, a mismatch in electronic experience, due to a high level of either type of experience and a low level of the other, was connected to the opposite pattern: difficult texts were read at a higher speed than stories which were perceived to be easier to comprehend. Interestingly, a low score in both electronic reading experience measures was connected to a pattern that was similar to high TR-EEXP (see Figure 4.5).

Figure 4.5

The Effect of TR-EEXP and Situational Competence on Reading Speed



Note. The lines show the model fit and the shaded areas show 95% confidence interval. TR-EEXP (Task-relevant Electronic Reading Experience) is measured by two measures: Electronic Experience 1 shows frequency of reading task-relevant text types electronically, and Electronic Experience 2 shows frequency of using task-relevant digital devices for recreational reading. Reading speed is measured by reading rate which indicates reading speed on each page-view divided by baseline speed. The predictors were centered around the mean and scaled.

Additionally, reading speed was predicted by contextual competence (see Table 4.4). The finding showed that participants who perceived themselves to be highly proficient readers were more likely to use faster reading speeds than participants who reported a lower reading skill.

The task-contexts model was used to assess how reading speed varied within the context of the reading task. We expected latter reading sessions, further locations in the text, and the beginning of reading sessions to be associated with baseline-level or slower reading speed. The findings showed that timings of reading sessions were not connected to speed, and so our hypotheses H2.2b and H2.4b were not supported. Location in text, on the other hand, was a significant predictor in the model, supporting our hypothesis H2.3b. The effect showed that participants reading speed increased towards the end of the text (see Table 4.5 and Figure 4.3 B).

Finally, reading speed was significantly predicted by behaviour at the previous events ($Event_{k-1}$ and $Event_{k-2}$; see Table 4.5). A fast reading speed at $Event_k$ (the outcome variable) was likely to follow from a similarly high reading speed at $Event_{k-1}$ and $Event_{k-2}$. Therefore, consecutive pages were likely to be read at a similar speed.

4.3.3.3 Linearity of Reading

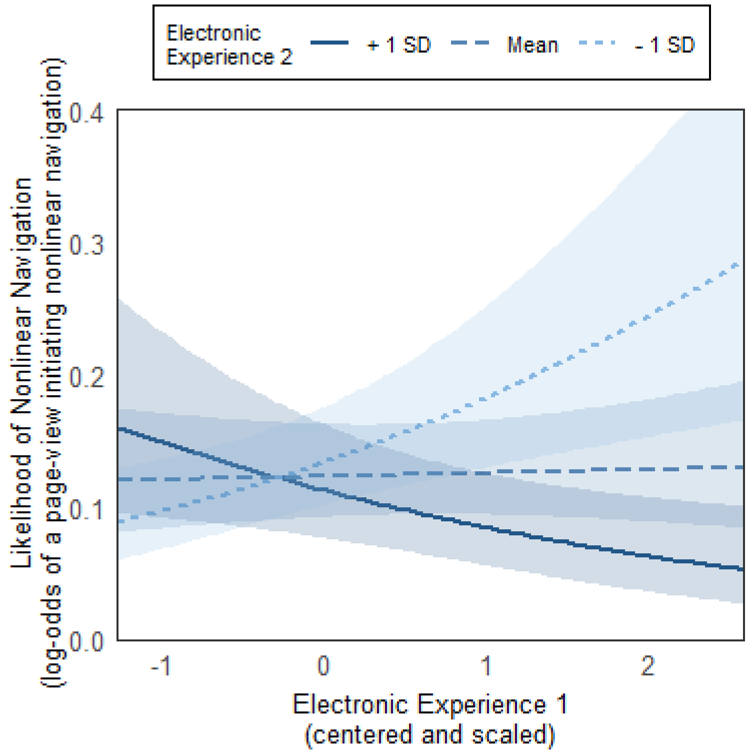
Participants varied in how linearly they read the short story (see Figure 4.3 C). On average, participants made 8.8 regressions (*SD* = 8.8) and 1.2 forward leaps (*SD* = 1.9) while reading the text. This nonlinearity was measured by a binary variable indicating whether nonlinear navigation was initiated on each page-view (see Figure 3.6 in Chapter 3).

First, nonlinearity was modelled by reader characteristics. We expected an interaction between situational competence and the two motivation measures, condition and contextual interest, to be connected to frequency of initiating nonlinearity (H1.1e and H1.2e). However, these hypotheses were not supported as the interaction effects were not significant predictors of nonlinearity (see Table 4.4). This indicates that motivation was not connected to nonlinear navigation via text difficulty, contrary to our expectations.

An interaction between the TR-EEXP measures and situational competence was similarly expected to be connected to nonlinear navigation patterns (H1.3e). The three-way interaction effect was not significant, and thus our hypothesis was not supported. Interestingly, a two-way interaction between the electronic reading experience measures was a significant predictor of linearity (see Table 4.4). The finding showed that a high score in the TR-EEXP measures was associated with a lower likelihood of nonlinear navigation (see Figure 4.6). In contrast, a mismatch in the measures – indicated by a low score in either measure and a high level of the other - was associated with frequent nonlinear navigation. A low score in both TR-EEXP measures was connected to low likelihood of nonlinear navigation, similarly to high levels of TR-EEXP (see Figure 4.6). Overall, this indicates that electronic experience was connected to participants' linearity of reading, although not via situational competence like we expected.

Figure 4.6

The Effect of Task-relevant Electronic Reading Experience on Linearity of Reading



Note. The lines show the model fit and the shaded areas show 95% confidence interval. TR-EEXP (Task-relevant Electronic Reading Experience) is measured by two measures: Electronic Experience 1 shows frequency of reading task-relevant text types electronically, and Electronic Experience 2 shows frequency of using task-relevant digital devices for recreational reading. Linearity of reading is measured by a binary variable indicating whether each page-view initiates nonlinear navigation or not. The outcome variable is shown as log-odds, the predictors have been centred around the mean and scaled.

Second, linearity of reading was modelled by the task-contexts model to study how linearity varied across the reading task. We expected participants to use nonlinear navigation more frequently at the beginning of reading sessions, in early reading sessions, and early on in the text (H2.2c, H2.3c, and H2.4c). Although the main effect of location in text or reading session number were not significant predictors in the model, a main effect of time since the beginning of the reading session showed that the odds of nonlinear navigation were highest at the beginning of reading sessions (see Table 4.5), supporting our hypothesis H2.4c. This indicates that nonlinearity was used primarily when the participants settled down to read the story. The main effect was qualified by a significant interaction between time in a reading session and location in text. The finding showed that nonlinear navigation was most likely when the participants were at the beginning of the story at the beginning of a reading session. This indicates that nonlinear navigation may have been most likely at the beginning of the reading task.

In addition, the results showed that nonlinearity was connected to the ways in which the text had previously been navigated (see Table 4.5). Participants were more likely to initiate nonlinear navigation if the previous event ($Event_{k-1}$) did not initiate nonlinearity. In other words, participants were unlikely to move between different types of nonlinear navigation (e.g., from a regression to a forward leap) in consecutive navigation events. Unlike findings on reading speed, $Event_{k-2}$ was not connected to the odds of nonlinear navigation at $Event_k$.

Table 4.5

Results from Task-context Models in Chapter 4

	Task-Switching Frequency		Reading Speed		Linearity of Reading	
	b	*SE*	*b*	*SE*	*b*	*SE*
Fixed effect						
Intercept	2.170***	.148	1.120***	.030	-3.172***	.274
Window Width	.144	.116	-.015	.022	.163	.127
Days Until Reading Deadline	-.298*	.114	.047	.032	-.099	.102
Event k-1	-.218*	.108	.067***	.009	-1.816***	.478
Event k-2	-.041	.107	.023*	.009	.172	.137
Reading Session Number (RSN)	-.290	.134	.025	.020	.001	.109
Time in Reading Session (TRS)	.173	.201	-.014	.016	-.428**	.151
Location in Text (LT)	.106	.116	.056***	.012	-.018	.080
Event k-1 x Event k-2	.330**	.118	-.013	.007		
RSN x TRS	.052	.157	.025	.014	.085	.107
RSN x LT	.062	.075	-.017	.009	.114	.070
TRS x LT	-.102	.081	-.011	.010	.196**	.073
Story 1	.641	.380			.321	.366

Story 2	.763	.558			-1.007	.700
Story 3	-.135	.410			.613	.400
Story 4	-.124	.336			-.119	.454
Story 5	-.945	.639			-.152	.366
Story 6	-.001	.344			-.206	.420
Story 7	1.295*	.517			-.272	.324
Story 8					-.101	.383
Random effect	*Variance*	*SD*	*Variance*	*SD*	*Variance*	*SD*
Subject indicator	.193	.440	.023	.151	.392	.626
DUD (slope)			.003	.055		
TRS (slope)	.467	.684			.249	.499
Event k-1 (slope)					1.385	1.177
Short story indicator	*FE*	*FE*	.003	.052	*FE*	*FE*
DUD (slope)			.005	.074		

Note. Continuous variables have been centered around the mean and categorical predictors were given Helmert contrasts. Event k-1 describes the previous event, and Event k-2 shows the event preceeding the previous (compared to Event k which represents the outcome variable). See Appendix D, tables D1, D2, and D3 for detailed information on all models. One short story level was removed from task-switching frequency analysis, see Appendix D for more detail. *FE* = fit in the model as a fixed effect, *b* = coefficient, *SE* = standard error, *SD* = standard deviation, '*': $p < .05$, '**': $p < .01$,'***': $p < .001$.

4.4 Discussion

The aim of this study was to enhance our understanding of the ways in which adults read fiction electronically. Reading behaviour was tracked on participants' own digital devices to assess their task-switching frequency, reading speed, and frequency of nonlinear navigation during reading of a short story. Situational motivation to read the story was manipulated by giving half of the participants a sense of autonomy over text selection, whereas the other half were asked to read a short story that they would not have selected for themselves. The autonomy manipulation, contextual motivation, and TR-EEXP (task-relevant electronic reading experience) were expected to be connected to participants' reading behaviour. Furthermore, we assessed the connection between task-context and reading behaviour to study how reading behaviour varies during the reading task.

4.4.1 Reader Characteristics

4.4.1.1 Reading Motivation

Contrary to our expectations, the motivation condition was not a significant predictor of reading behaviour. This was surprising as previous studies have linked situational motivation to lower distractibility (Ralph et al., 2021), persistent engagement with the text (List et al., 2019), and more linear reading patterns (Garces-bacsal & Yeo, 2017). The nonsignificant findings could be due to the limited impact of the autonomy manipulation. Indeed, participants in the two conditions differed only by .84 points (on a 7-point scale) in their situational motivation. The small difference may have not resulted in noticeable variation in reading behaviour.

The autonomy manipulation was based on participants' ratings for summaries of the available short stories: whereas participants in the low autonomy condition were assigned to read the story that they rated lowest, participants in the high autonomy condition were given a story that they gave the highest rating. Accordingly, the manipulation may have not had the desired effect if the participants did not have strong feelings towards any of the summaries. Indeed, further inspection of the summary ratings showed that 10% of participants would have been happy to read any of the stories, and one participant was not interested in any of them (see Appendix C, Figure C1).

Alternatively, the autonomy manipulation may have had a limited effect on behaviour if the participants struggled to accurately judge whether they would enjoy the text or not based on its summary. Text selection is a complex and difficult process that requires the reader to assess the text genre, topic, and the extent to which the reader can identify with the characters (Lepper et al., 2022). This information can be difficult to capture from an extract, and instead, readers often use covers and recommendations from friends to decide if a book would be interesting for them (Mckay et al., 2021; Rinehart et al., 1998). When only a summary is available, readers make predictions on what will happen in the text, how action-packed and suspenseful the story is, how it is written, and whether it will appeal to them (Rinehart et al., 1998). Accuracy of these inferences can vary widely, and accordingly, readers regularly come across books that disappoint them or turn out to be a pleasant surprise (Rinehart et al., 1998). Accordingly, autonomy in text selection does not guarantee a pleasant reading experience: the reader needs to be able to select which texts will sustain their attention (Worthy et al., 2001). It is possible that the participants struggled to assess the summaries accurately, and indeed, 43% of participants in the low autonomy condition reported that they enjoyed the short story despite their low rating for the story summary (see Appendix C for the story ratings).

Whereas situational motivation was not connected to reading behaviour, contextual motivation showed a different pattern of results. The findings showed that participants who enjoy reading as an activity engaged continuously for longer at a time, and thus task-switched less, supporting our hypothesis H1.2c (see Table 4.1). Similar results have been reported previously in self-report studies, indicating that contextual motivation can support engagement in an activity (Levine et al., 2022) and result in immersive flow experiences which are characterised by extended attention to a task (McQuillan & Conde, 1996).

Contextual motivation was linked to reading speed via an interaction with situational competence. Participants who were motivated to read for pleasure used slower reading speeds when the text was perceived to be difficult, and faster speeds when the text was easy. Previous studies have shown that this alternation is important for comprehending difficult texts (e.g., Brysbaert, 2019). Interestingly, participants with lower contextual motivation showed the opposite pattern: they read difficult texts at a fast speed and slowed down when reading easier texts. One plausible explanation for this difference is that contextual motivation modulates readers' response to task demands. Motivated readers' interest in the activity may have encouraged them to read the text more carefully, whereas lower levels of contextual motivation could have caused the readers to neglect the importance of reading difficult texts slowly. Previous studies have indicated that difficult and uninteresting tasks are seen as unrewarding and resource-depleting, which can cause readers to devote less cognitive resources to them (Soemer & Schiefele, 2019). Motivated readers may be more likely to struggle through difficult texts, a finding that was echoed in an interview study by Worthy et al. (2001). Accordingly, low contextual motivation may have encouraged participants in the current study to speed through difficult sections of the text if they were not interested in devoting the resources to comprehend the text in full.

In addition to alternations in reading speed, varying one's linearity of reading is important for comprehension (Schotter et al., 2014). Previous studies have made this connection by eye-tracking during reading of short passages (e.g., Schotter et al., 2014); however, our findings indicate that frequency of nonlinear navigation on the page-level may be similarly connected to text difficulty. High text difficulty was associated with frequent nonlinear navigation, whereas easier texts were read more chronologically.

We expected participants' contextual motivation to be connected to their frequency of nonlinear navigation via an interaction with text difficulty. This hypothesis was not supported, which was surprising considering that variance in reading speed could be partly explained by text difficulty and contextual motivation. It is possible that nonlinear navigation is more automatic and reactive compared to alternations in reading speed, and so it may not be dependent on participants' motivation to understand the text. In eye-tracking research, regressions backward in text have been found to be largely automatic (Rayner et al., 2016), however it is unclear to what extent nonlinear navigation on the page-level is consciously controlled behaviour.

4.4.1.2 TR-EEXP

In addition to motivation, reading behaviour was connected to participants' experience with electronic reading. The findings showed that participants with a high level of task-relevant experience read the story slowly if the text was difficult, and at a faster pace if the text was easy. In contrast, a mismatch in the two TR-EEXP measures, indicating a high level of one type of task-relevant experience and a low level of the other, was connected to fast reading speeds when the text was difficult to read, and a slower reading rate when the text was easy. This pattern of results resembles our finding on contextual motivation and reading speed, and indeed, it is possible that TR-EEXP supports readers in reacting to task-demands, similarly to motivation.

Interestingly, participants' linearity of reading was connected to TR-EEXP independently from text difficulty. The results showed that participants with task-relevant experience read the text more linearly compared to the less experienced participants, regardless of how difficult the text was. This indicates that page-level nonlinear navigation may not tell us about text difficulty, whereas a robust effect between the two has been found in eye-tracking research during reading of short passages of text (Schotter et al., 2014). Instead, TR-EEXP may guide readers' navigation patterns across multiple pages.

4.4.2 Task-contexts

In addition to reader characteristics, reading behaviour was assessed in relation to the task-context. We expected participants to exhibit different reading behaviour at the end, compared to the beginning of the reading task (H2.2a-H2.2c and H2.3a-H2.3c, see Table 4.1). The beginning of narrative texts can feel arduous to read as the reader needs to familiarise themselves with the setting, the characters, and the author's writing style (Syd Field, 2005), which may result in a slower reading speed and more frequent task-switching (Rosenthal, 1995). Furthermore, readers may wish to explore the text structure and length by nonlinear navigation before they commit to reading it (Milne, 2021). As readers become more familiar with the narrative, they can read at a faster pace, and even become immersed in the text (McQuillan & Conde, 1996). Accordingly, we expected participants to read the beginning of the text at a slower reading rate, disengaging from it more frequently, and relying on nonlinear navigation more often, compared to the end of the text.

The findings showed that reading speed was positively connected to location in text, and therefore, participants increased their speed towards the end of the story, in accordance with our hypothesis H2.3b (see Table 4.1). A similar finding has been reported in eye-tracking research; for example, Demberg and Keller (2008) and Kaakinen et al. (2018) found reading speed to increase towards later parts of a text. This could indicate the readers' anticipation of finishing the reading task, or their increasing familiarity with the writing style. Similarly, linearity of reading was connected to location in text: participants were most likely to initiate nonlinearity when they were at the beginning of the text in the beginning of a reading session. This behaviour could be similar to what Milne (2021) described as a habit of 'good readers' - exploration of the text and its structure by nonlinear navigation before reading it.

In contrast, task-switching frequency was not associated with timing of reading sessions or location in text. Therefore, the beginning of the task was not connected to more frequent disengagements from text, contrary to our expectations. It is possible that the effect is confounded by other task-contexts that could not be measured in the current study, such as reading location. Although task-switching is often connected to difficulty staying focused on the task, it can also be a characteristic of a reading session: interview findings by Nolan-Stinson (2008) and Rosenthal (1995) showed that avid readers occasionally read outside of their home, in environments that require them to frequently disengage from the text. As participants' reading location was not available to us, it was not possible to distinguish between task-switching due to internal and external distractions.

In addition, we expected time within a reading session to be connected to reading behaviour (H2.4a-H2.4c, see Table 4.1). Previous studies have indicated that readers often struggle to settle down to read at the beginning of a new reading session, resulting in frequent disengagements and a slower reading speed (e.g., Rosenthal, 1995). However, our findings showed that task-switching and reading speed were not associated with timing in a reading session, suggesting that participants did not noticeably struggle to focus on the text. Instead, time in a reading session was a significant predictor of nonlinear navigation, suggesting that participants used nonlinear navigation more often at the beginning rather than the end of reading sessions. This shows that nonlinear navigation was connected to continuing the short story, rather than starting it. It is possible that the participants used nonlinear navigation to reread previously read parts of the story to remind themselves of where they left off. A similar finding was reported by Iqbal and Horvitz (2007): after a break, workers reminded themselves on where they left off on their work tasks by opening previously used applications and rereading text.

Finally, the results showed that reading behaviour could be predicted by behaviour in the participants' previous two events, $Event_{k-1}$ and $Event_{k-2}$. Reading speed at $Event_{k-1}$ and $Event_{k-2}$ was positively associated with speed at $Event_{k}$, indicating that consecutive pages were read at constant speed. Results on task-switching frequency, on the other hand, showed that participants either engaged for long continuous durations consistently, or they frequently alternated between short and long continuous engagement durations. Findings by Kononova et al. (2016) showed that adults can differ widely in their preference for task-switching, which could be reflected in these results.

Similarly to reading speed and task-switching, linearity of reading was connected to the previous event. The finding showed that alternation between forward leaps and regressions was uncommon, and instead, participants were likely to move between linear and nonlinear navigation rather than different types of nonlinearity. However, the event preceding the previous, $Event_{k-2}$, could not be used to predict linearity at $Event_{k}$. This indicates that nonlinearity may have been used for a variety of different purposes during the study. Some participants may have used nonlinearity primarily to enhance their comprehension by moving backwards in text to reread the previous page. Others may have varied their linearity frequently to relieve feelings of boredom, for example, by browsing the text. These differences would have made it difficult to predict linearity by events preceding the previous.

4.4.3 Limitations

The current study provides rich descriptions of adults' fiction e-reading behaviour using a novel method. It showcases the potential of the e-reader system and provides a foundation for the following studies that are presented in Chapters 5 and 6. However, the study also has some limitations.

Short stories were used due to time constraints in data collection. However, the reading task may have not been sufficiently long to observe reading behaviour comprehensively. In adults' everyday life, recreational reading materials are likely to consist of full-length novels which are read in multiple reading sessions, in a variety of locations (Merga, 2017b). Behaviour may vary across these reading sessions, as a reflection of the reader's mood and responsibilities. Therefore, longer texts may allow us to better capture adults' natural reading behaviour.

The autonomy manipulation allowed us to measure the effect of low situational autonomy on behaviour, however, as a trade-off, it lowered the ecological validity of the study. Adults are generally offered the freedom to select their own reading material, and so the autonomy manipulation may have felt artificial to the participants. To achieve a naturalistic reading environment, adults should be allowed to select their own reading materials.

Finally, participants' situational motivation may have been biased by the monetary compensation. Deci et al. (1999) argue that rewards influence motivation, and they can even turn autonomous motivation into controlled motivation. Indeed, the compensation may have undermined our manipulation, which aimed to influence participants' situational motivation by their autonomy in text selection. Monetary compensation was primarily used to access a wider participant pool: we expected that only avid readers would be attracted to the study in the absence of compensation, and therefore it was decided that a reward would be favourable to a biased sample. However, in following studies, we pursue to use compensation that does not bias situational motivation.

4.5 Conclusion

In this chapter, we used the e-reader system to track sixty undergraduate students' reading behaviour during reading of a short story. The participants' situational motivation was manipulated by influencing their autonomy in text selection. The findings showed that the autonomy manipulation successfully influenced participants' situational motivation, however, the manipulation did not result in the expected effect in reading behaviour. Instead, the findings suggested that contextual motivation may support readers in reacting to text difficulty adaptively, and TR-EEXP can support linear reading patterns. In terms of task-contexts, the results showed that participants increased their reading speed towards the end of the text, and they reread text in the beginning of reading sessions, potentially to remind themselves on where they left off. These findings provide novel information on how reader characteristics and task-contexts influence adults' electronic reading behaviour. The study provides a strong foundation for further study, however, our findings may have been influenced by the short length of the texts and the monetary compensation used. In Chapter 5, we address these limitations by tracking behaviour during reading of full-length novels, and by using a more ecologically valid experimental setup. Participants were allowed to select their own reading materials from a library of bestselling novels, and instead of monetary rewards, they were compensated with an infographic on their own reading behaviour.

Chapter 5

Reading Behaviour During Reading of a Full-length Novel

5.1 Overview

The previous chapter explored reading behaviour during reading of a short story. Although the findings provided rich descriptions of e-reading behaviour, the study was limited by the short length of the reading materials. Indeed, recreational reading is usually a longitudinal process. Adults tend to read novels for leisure (Smith, 2000), which can span from 80 to over 1000 pages in length.

Whereas short texts can be read in one sitting, reading a full-length novel requires a considerable time-investment. An average reader, reading 260 words per minute (wpm), takes approximately 5.6h to read a 350-page book[10]. Few have the time and energy to finish a novel in one reading session, and so long texts often require the reader to section their reading time into multiple reading sessions (Braslavski, Petras, et al., 2016; Merga, 2017b). This is likely to have an impact on reading behaviour. Becoming engaged in the book in a new reading session requires that the reader remembers information that was read in the previous session. To refresh their memory, readers may need to reread previously read sections of the text at the beginning of a new reading session (Iqbal & Horvitz, 2007).

The effort and time-investment associated with book reading are likely to place higher demands on readers' motivation. Previous studies have shown that adults can persist with effortful activities for a short period of time despite their interest in the task; however, engagement becomes increasingly difficult to maintain with time (Paulitzki et al., 2008). Mind-wandering and task-switching can become increasingly likely for individuals with controlled reading motivation, whereas motivated readers' engagement with the text is likely to remain sharp as they find the reading activity worthwhile (Deci & Ryan, 2000; Tulis & Fulmer, 2013). Indeed, Kuzmičová et al. (2020) suggest that motivated readers may experience *long-term immersion* in a novel when the reader continues to think about the story in between reading sessions, and thus continues *"to live with a piece of fiction beyond instances of reading"* (p. 11). These positive experiences are likely to result in frequent and

[10] Assuming that the book has approximately 250 words on each page.

longer reading sessions, whereas low motivation to read the book can make the individual gravitate towards other activities (Brinda, 2011; Fulmer & Frijters, 2011).

To fit as many reading sessions as possible in their busy daily schedule, highly motivated adults may read flexibly at any opportune moment (Nolan-Stinson, 2008). Reading the text 'on the go' is likely to result in more frequent distractions than reading in a disruption-free environment (Kosch et al., 2021; Kuzmičová et al., 2020). In particular, reading sessions may include frequent interruptions, slower reading speed, and more frequent nonlinear navigation if the reading task becomes a secondary activity, for example, when the reader needs to keep track of when to get off a bus or listen in on when they are called in for an appointment. Interview findings by Rosenthal (1995) and Kosch et al. (2021) indicated that many avid readers find this distractible reading engagement preferrable to reading less frequently.

Similarly to motivation, print exposure may contribute to the ways in which adults read longform texts. As described in Chapter 2, print exposure refers to the extent to which a person has been surrounded by literature over their lifetime (Mol & Bus, 2011). For example, adults with high print exposure have often had books read to them in childhood (Zare et al., 2023) and they take part in reading-related activities, such as book browsing in libraries, book sharing with friends, or book-related social media (Rain & Mar, 2014). Those with high levels of print exposure tend read in high volume, more frequently, and at a faster speed (Mol & Bus, 2011; Moore & Gordon, 2015), suggesting that print exposure may influence reading behaviour. However, it is unclear to what extent the association between print exposure and reading behaviour is independent from reading motivation: adults with more autonomous contextual motivation tend to have high levels of print exposure, often due to positive experiences with book sharing in childhood (Baker et al., 2001). Indeed, print exposure in childhood has been suggested to be a precursor of later reading motivation (Mol & Bus, 2011), but it would be plausible to expect that a high level of print exposure may also develop over time if an individual reads often, takes part in reading-related activities, and so becomes increasingly familiar with literature.

In addition to motivation and print exposure, the readers' experience with the reading format is likely to have a considerable impact on reading behaviour during book reading. Low compatibility with the reading format can make it difficult for the reader to remain engaged with the text (Chau & Hu, 2001). This can feel frustrating for the reader over time and make them less likely to persist in reading the book in this format (Chau & Hu, 2001). For example, a study by Vernon (2006) showed that students in a class could be initially compelled to use an electronic textbook, however, after two weeks the majority of them decided to rely on paper copies instead. Similarly in fiction reading, individuals with little experience of electronic books may find it difficult to focus on electronic versions of the text and so they may feel compelled to stop reading the book. On the other hand, readers with task-relevant electronic reading experience (TR-EEXP) are likely to find electronic texts easy to use: experienced readers have incorporated digital reading in their daily lives, and so they are familiar with the affordances that these reading formats offer (Kosch et al., 2021; Yoo & Roh, 2019).

Overall, long-form texts such as novels are likely to result in different reading behaviour than reading of short texts. Despite fiction books being the most popular recreational reading material (Nielsen, 2016), few studies have assessed reading behaviour during reading of longform texts. To address this gap in previous research, we present a large-scale study (*n* = 733) on longitudinal electronic reading behaviour during reading of a full-length novel. Participants were allowed to use the e-reader system at their leisure for 11 months while their reading behaviour was tracked unobtrusively.

Whereas in Chapter 4 participants' situational motivation was manipulated by assigning them to read a specific short story, we pursued to improve the ecological validity of our methodology by allowing participants to choose a text from a selection. To ensure that the available reading materials were attractive to the participants, we collaborated with bestselling authors to create a varied library of popular books.

Unlike in Chapter 4, no experimental manipulation or monetary compensation was used in the current study. Instead, we incorporated a natural manipulation to create variation in reading behaviour: participants were told that they would be asked to read up to 70 pages of their selected novel, after which they would receive an infographic on their own reading behaviour as compensation for taking part. Participants were allowed to continue reading the book after this point, but they were not required to do so to complete their participation. The infographic threshold, therefore, acted as the first opportunity for the participants to stop reading and finish the study. Similar approaches have been used in previous studies, and for example, Fulmer and Frijters (2011) and Tulis and Fulmer (2013) asked participants whether they would like to finish reading a short story or stop reading it after the first page. Their findings showed that situationally motivated participants were more likely to persist in reading the text. Accordingly, we hypothesised that participants' reading persistence beyond the infographic threshold would be connected to situational autonomous motivation (see Table 5.1, H1.1a).

Due to the scale of this study, we were able to address all hypotheses set in Chapter 2 (reiterated in Table 5.1). Therefore, we expected participants' situational and contextual reading motivation and task-relevant electronic reading experience (TR-EEXP) to be associated with higher reading persistence (H1.1a-H1.3a), higher reading frequency (H1.1b-H1.3b), and lower task-switching frequency (H1.1c-H1.3c). Furthermore, we expected motivation and TR-EEXP to support readers in reacting to text demands by slowing down their reading speed and by rereading text (H1.1d-H1.3d and H1.1e-H1.3e). No hypotheses were set on the connection between print exposure and reading behaviour due to the potentially mediating effect of reading motivation.

Similarly, we aimed to address all our hypotheses on the relationship between task-contexts and reading behaviour. To collect information on the location of reading sessions, participants were asked to self-report on their reading location at the beginning of each session by responding to a multiple-choice question. Reading locations outside of the home were expected to support frequent reading engagement but also result in frequent distractions. Thus, we predicted that reading outside of the home would be connected to higher reading frequency (H2.1a), more frequent task-switching (H2.1b), slower reading speed (H2.1c), and more frequent nonlinear navigation (H2.1d). The beginning of the reading task was expected to be distractible due to low familiarity with the writing style and the story premise, and so we expected participants to task-switch frequently (H2.2a and H2.3a), use slower reading speeds (H2.2b and H2.3b) and use frequent nonlinear navigation (H2.2c and H2.3c) at the beginning of the text and in early reading sessions. Finally, early on in the reading sessions participants were expected to have a higher incidence of task-switching (H2.4a), slower reading speed (H2.4b), and frequent nonlinear navigation (H2.4c) if they struggled to settle down to read the text, as described in an interview study by Rosenthal (1995). Additionally, we assessed whether participants' reading behaviour could be predicted by their previous events, however, no hypotheses were set due to limited previous research.

Table 5.1

Summary of Hypotheses Addressed in Chapter 5

RQ1: Reader characteristics	Higher reading persistence	Higher reading frequency	Lower task-switching frequency	Baseline-level and slower reading speed when situational competence is low	More frequent nonlinear navigation when situational competence is low
Situational autonomous motivation is connected to...	H1.1a	H1.1b	H1.1c	H1.1d	H1.1e
Contextual autonomous motivation is connected to...	H1.2a	H1.2b	H1.2c	H1.2d	H1.2e
Task-relevant electronic reading experience is connected to...	H1.3a	H1.3b	H1.3c	H1.3d	H1.3e

RQ2: Task-contexts	Higher reading frequency	Lower task-switching frequency	Baseline-level and slower reading speed	More frequent nonlinear navigation
Reading location outside of the home is connected to...	H2.1a	H2.1b	H2.1c	H2.1d
Early reading sessions are connected to...		H2.2a	H2.2b	H2.2c
Early locations in text are connected to....		H2.3a	H2.3b	H2.3c
The beginning of reading sessions is connected to...		H2.4a	H2.4b	H2.4c

Note. The highlighted cells indicate which hypotheses could be addressed in the study reported in this chapter.

5.2 Method

5.2.1 Participants

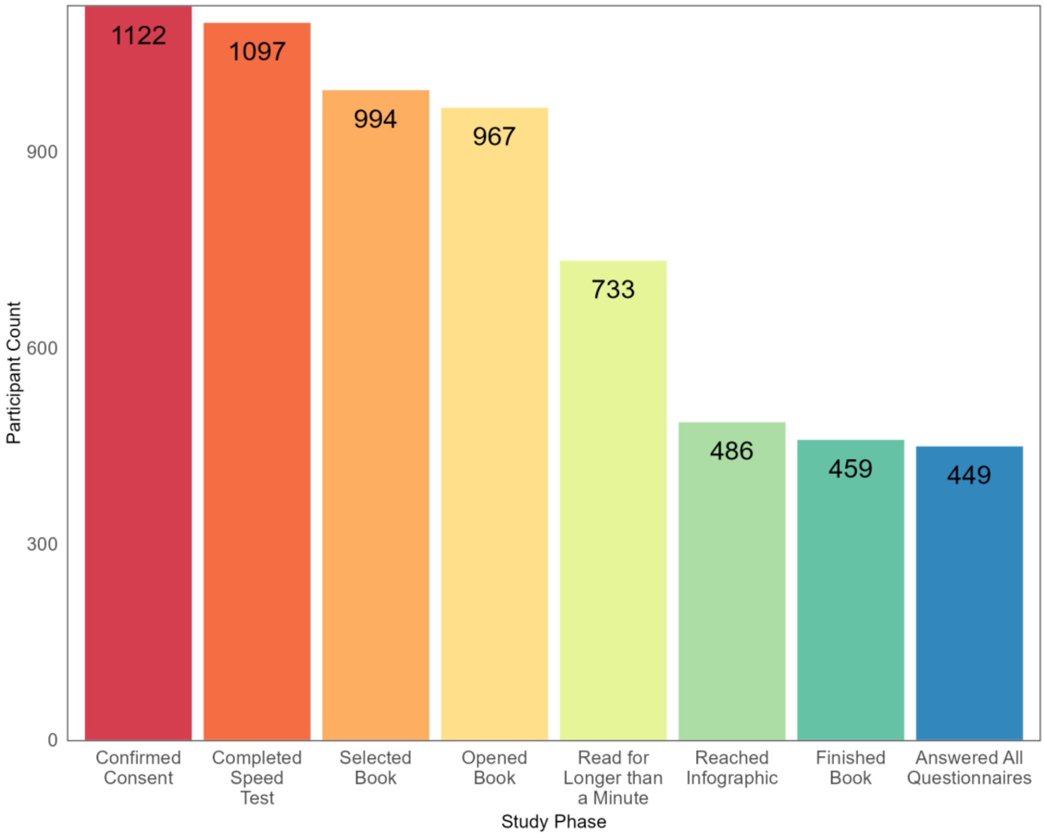
In total, 1,122 adults signed up to participate in the study. The participant recruitment was carried out online via social media. Our aim was to recruit a large sample of adults, and to make this possible, we reached out to organisations, charities, libraries, authors, politicians, and influencers, and asked them to share information about the study in their social media channels (see Appendix E for the advertisements used). Participants were expected to be over 18-years of age and have access to a digital device that they could use to access the e-reader system. We did not place limitations on participants' geographic location or language skills. Instead, participants who could understand the information forms and register for the study were expected to be proficient enough in English to participate in the study.

Only participants who reached the main phase of the study and used the e-reader for at least a minute were included in the sample. The sample included 733 participants, which represented 65.3% of the participants who signed up to the study. Of these participants, 61.3% completed the study in full (n = 449). Using two different reader characteristics models, we studied participants who did and did not finish the study separately. This is because participants who dropped out of the study prematurely may have differed from the rest of sample, for example, due to low reading motivation. Therefore, whether the study was finished or not was expected to be an important variable in the analyses. See Figure 5.1 for information on participant retention rates at different parts of the study.

Some of the participants reported technical difficulties in using the e-reader. Compared to the previous study, more issues were expected considering that the sample was considerably larger and some of the participants may have used devices that were not tested during the development of the e-reader system. Four participants were excluded from the study due to major technical difficulties. These participants reported considerable issues in the usage of the e-reader system on their devices. One participant reported that the e-reader frequently sent them to the beginning of the book, forcing them to manually navigate back to the correct reading position. Another participant indicated that the e-reader system text mask occurred too quickly for them, which forced them to re-activate the e-reader on every page. Finally, two participants reported that the e-reader would not let them finish the book: one participant mentioned that the e-reader *"only went to 36% and no further"*, whereas the other indicated that they couldn't get past 53%. These technical difficulties would have resulted in a considerable amount of noise in the data and so the participants were excluded from the sample.

Figure 5.1

Participant Retention Rates at Different Parts of the Study



Note. Participant counts are shown before the exclusions described in text.

Furthermore, 99 participants reported minor technical issues in the usage of the e-reader. Thirty-seven reports were about one-off issues in the text layout or e-reader function, and another 37 participants indicated of slightly more persistent issues, such as misfunctioning of automatic bookmarking that may have caused the participants to lose their place in the text in between reading sessions, or overlapping text in more than one section of the book. Finally, 23 participants had difficulty accessing their infographic and 2 participants did not receive a location prompt question at the beginning of each reading session. These participants were not excluded from the study, however, the influence of the issues were considered in analyses.

In total, the sample included 729 participants. See Table 5.2 for demographic information. Participants were not given monetary compensation, but instead, access to the book catalogue and an infographic on participants' own reading behaviour was used as an incentive to take part (see Figure 5.6 for an example of the infographic). The experimental design was approved by the School of Informatics Ethics committee (ref: 2019/81073). Informed consent was obtained from all participants, and participants were sent a debrief sheet with more information at the end of the study.

Table 5.2

Participant Demographics in Chapter 5

		Total	Did Not Finish Study	Finished Study
		729	284	445
Age				
	18-29	177	91	86
	30-39	173	74	99
	40-49	155	48	107
	50-59	134	48	86
	60+	90	26	64
Education Level				
	High School or Lower	62	29	33
	College or Vocational School	110	46	64
	Undergraduate Degree	241	102	139
	Postgraduate Degree	316	110	206
Gender				
	Female	624	229	395
	Male	93	51	42
	Other or Prefer Not to Say	12	7	5
Native English Speaker?				
	Yes	581	218	363
	No	148	69	79

5.2.2 Materials: The Questionnaires

Similarly to Chapter 4, we used questionnaires to capture participants' motivation and electronic reading experience. IMI-R (Intrinsic Motivation Inventory in Reading) and IMI (Intrinsic Motivation Inventory) were used in the same manner as in Chapter 4, whereas the electronic reading experience questionnaire was slightly modified. Instead of asking participants about which digital devices they own, we asked them to report which digital devices they have access to in order to capture usage of devices that are borrowed, used in public locations, or shared with family or friends. Furthermore, an item was added to the beginning of the questionnaire to ask participants about which digital devices they use specifically for reading purposes. See Appendix A for the electronic reading experience questionnaire with information on changes done for the current study.

The internal consistency of IMI and IMI-R was found to be good, $\alpha_{IMI-R} = .891$, $\alpha_{IMI} = .899$. Again, three subcomponents were used from IMI to measure situational reading motivation (interest, autonomy, and competence), and two components were used from the IMI-R to capture contextual reading motivation (interest and competence). The subcomponents showed good internal consistency (*range* α = .78- .92). The 'interest' subcomponents from IMI and IMI-R were used to represent participants' extent of autonomous situational and contextual motivation, respectively.

In addition to motivation and electronic reading experience, we measured participants' print exposure via the Author Recognition Test (ART). In the test, participants are asked to select the names of authors that they recognise from a checklist. The list includes a variety of bestselling authors, but also, multiple fabricated names. Print exposure score is calculated by comparing the amount of correctly identified authors to the number of chosen foils. The score therefore reflects the participants' familiarity with popular literature.

We used a version of ART developed by Fong et al. (2013) and Mar and Rain (2015) which includes 111 fiction authors and 40 foils (see Appendix A for the list of names used). The fiction authors on the list cover well-known and bestselling writers whose books were widely available in English in 2015 (Mar & Rain, 2015). The authors write in a variety of genres, ranging from science fiction and fantasy to translated literary fiction. Participants were asked to respond to ART at the beginning of the study, after IMI-R (see Figure 5.2).

Participants were not told that the list includes foils, and the order in which the authors were shown was randomised for each participant. In accordance with recommendations by Martin-Chang et al. (2020), participants were given a point for each real author name selected in ART, and the score was then adjusted by deducting two points for each foil selected.

In the reader characteristics models, contextual motivation was assessed by inspecting both participants' score on the IMI-R 'interest' subcomponent whereas print exposure was measured by ART score. Considering that previous studies have shown a connection between contextual motivation and print exposure (e.g. Mol & Bus, 2011), we fit the reader characteristics models with and without ART score to ensure that the model results were accurate and not affected by multicollinearity[11]

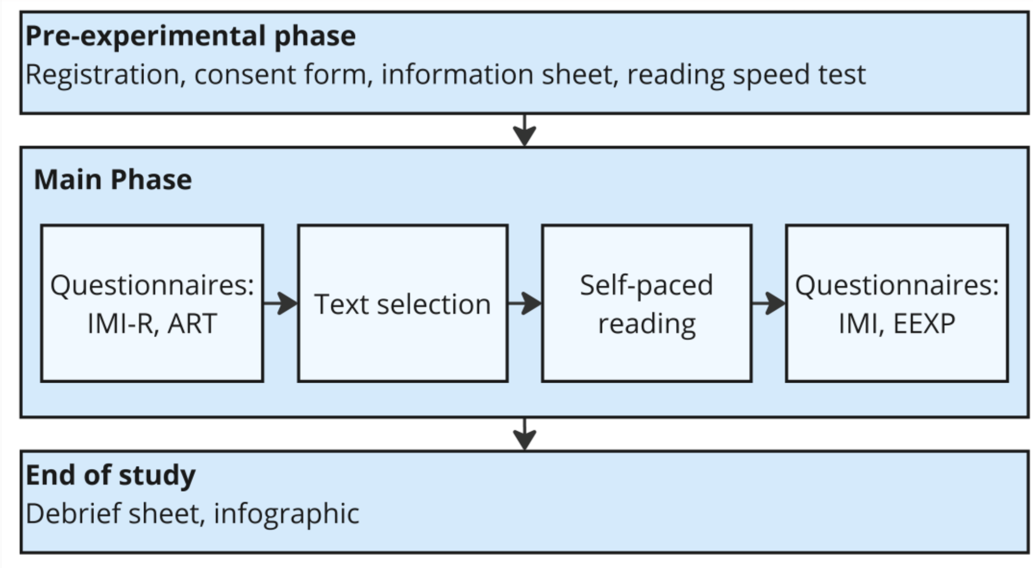
Individual items were used to gather additional information from participants. At the beginning of the study, information was collected on participants' age, gender, and education level. Furthermore, participants were asked to report on whether the COVID-19 pandemic had had an influence on their free time or reading habits. This was included considering that the study was conducted between August 2021 and June 2022, and so individuals' usual activities may have been limited by any COVID-19 restrictions or COVID-19 connected lay-offs. At the end of the study, participants were asked to provide a short summary of the book that they read during the study. The summaries were collected for future research purposes, and this analysis was beyond the scope of this thesis. Finally, participants were asked to provide feedback on the functionality of the e-reader system.

Due to the decline in retention rate across the study (see Figure 5.1), fewer participants completed the questionnaires that were placed at the end of the study. All participants retained in the study had scores on IMI-R and ART, however, only 61% of the participants (n = 449) finished the study in full, and thus completed all questionnaires. The missing questionnaire data is controlled in the data analysis by comparing results obtained with the full dataset to a subset with only participants who completed all questionnaires.

[11] In addition, all models were tested for multicollinearity as part of testing of the model assumptions.

Figure 5.2

Procedure of the Study on Book Reading



5.2.3 Materials: Books

Participants were asked to select a book to read from a selection of 16 fictional texts in English. To ensure quality and appeal of the texts, we contacted authors, publishers, and literary agents to obtain copyrighted, bestselling novels to use in the study[12]. In total, 8 of the books were donated by bestselling authors, 5 were public domain texts, and 3 of the books had a Creative Commons licence. The texts ranged between 22,155 to 243,835 words in length (approx. 89-975 pages), and they covered a wide variety of genres to cater for the participants' interests (see Table 5.3).

Participants were asked to select one text to read during the study. The selection was done in a library that was added to the e-reader system for the purposes of this study. In the library, participants were shown the covers and titles of the available books. The books were shown in a randomised order, with three books visible at once on a larger screen and one book on a small screen such as a smartphone (see Figure 5.3). Participants could cycle through all of the books in the library by either swiping on the screen, or by tapping the

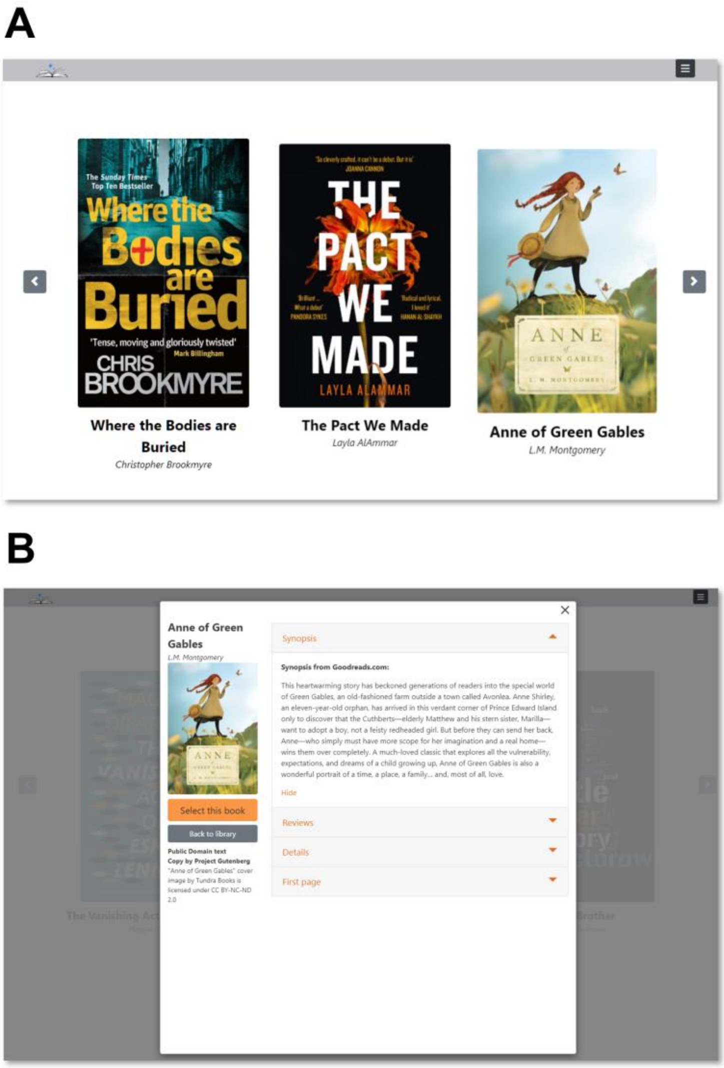
[12] In total, 83 different authors were contacted and asked to support the study. The contacted authors were selected from bestselling lists, and they were given information on the study. 28 of the contacted authors respondent to the request, resulting in text donations from 11 authors. Texts from seven different authors were obtained in time for the study. A copyright agreement was signed between the researcher, the primary supervisor (Prof Frank Keller), University of Edinburgh, the author, and any connected organisations, such as literary agency or publisher. Permission was obtained to refer to the inclusion of the copyrighted texts in the study in recruitment and publications.

arrows at the left and right side of the window (see Figure 5.3). Clicking on the title or the cover of a book opened more information on it: drop-down menus provided information on the length of the book, its genre, three recent reviews[13], and its first page for preview (see Appendix C for more information). Once the participant had decided which book to read, they clicked on 'Select this Book' on the information page (see Figure 5.3) to proceed to the reading phase of the study. The library browsing, including which information was viewed and for how long, was tracked by embedded tracking features, but this data was not analysed in this thesis.

[13] Reviews for each book were obtained from Goodreads.com by selecting three most recent reviews at the time (Summer 2021, before the beginning of the study). A permission to use each review in the study and resulting publications was obtained from all reviewers.

Figure 5.3

Screenshots from the E-Reader System Library



Note. A) Library view on a large device, such as a laptop or a PC. Smaller devices showed only one cover at a time. B) Book information view which was shown after participant clicked on a cover in the library.

Participants favoured selection of the copyrighted books (see Table 5.3). In total, 15.8% of the participants selected the most popular title, The Vanishing Act of Esme Lennox by Maggie O'Farrell, followed by Cleanskin by Val McDermid which was selected by 13.6% of the participants. The participants spent on average 40.8 minutes (*SD* = 70.1mins) using the library before selecting a book, and they viewed information on 3 different books (*SD* = 2.5).

Table 5.3

Text Characteristics of the Books Used in Chapter 5

Author	Title	Publication year	Publication type	Genre	Average Word frequency (SD)	Number of unique words	Text length (words)	Number of participants	Number of Pages Required for Infographic*
L. M. Montgomery	Anne of Green Gables	1908	Public domain	Classical fiction	10.94 (80)	7,383	107,010	24	70
Samantha Young	As Dust Dances	2018	Fully copyrighted	Romance	11.95 (83)	7,462	125,538	78	70
James Patrick Kelly	Burn	2005	Creative commons	Science fiction	6.49 (45)	4,983	41,150	8	70
Val McDermid	Cleanskin	2006	Fully copyrighted	Crime	5.52 (26)	2,971	22,155	97	45
Mary Wollstonecraft Shelley	Frankenstein	1818	Public domain	Classical horror	8.23 (69)	6,970	75,511	34	70
Cory Doctorow	Little Brother	2008	Creative commons	Science fiction	9.21 (79)	9,835	121,080	26	70
Louisa May Alcott	Little Women	1868	Public domain	Classical fiction	13.76 (130)	10,680	191,212	29	70
C. J. Tudor	The Burning Girls	2021	Fully copyrighted	Thriller	9.26 (70)	7,774	95,286	76	70
Scott Sigler	The Rookie	2007	Fully copyrighted	Science fiction, Sport	12.13 (111)	9,564	40,939	1	70

Layla AlAmmar	The Pact We Made	2019	Fully copyrighted	Literary fiction	7.19 (56)	7,815	74,987	38	70
Agatha Christie	The Secret Adversary	1922	Public domain	Mystery	9.09 (64)	6,522	78,604	49	70
Maggie O'Farrell	The Vanishing Act of Esme Lennox	2007	Fully copyrighted	Historical fiction	8.57 (71)	6,186	67,755	113	70
H. G. Wells	The War of the Worlds	1897	Public domain	Classical fiction, Science fiction	7.17 (70)	6,713	61,136	21	70
Scott Sigler	Title Fight	2009	Fully copyrighted	Science fiction, Sport	6.56 (45)	5,021	40,939	1	70
Brandon Sanderson	Warbreaker	2009	Creative commons	Fantasy	17.75 (159)	10,842	243,835	46	70
Christopher Brookmyre	Where the Bodies are Buried	2011	Fully copyrighted	Crime	9.32 (76)	9,475	113,103	73	70

Note.
*Number of pages required for infographic refers to the timing of the infographic threshold. The infographic threshold was reached once the participant had spent more time in the e-reader system engaged in reading than it would it have taken them to read this number of pages of the text in their baseline reading speed.

5.2.4 Materials: The E-Reader System

Reading behaviour was tracked by the e-reader system introduced in Chapter 3. The e-reader and its tracking functionality were slightly modified for use in the current study. Considering the large sample size, participants were asked to sign up for the study online instead of by emailing the researcher. For this purpose, a website was created in which participants could access information on the study, sign up to take part, and login to use the e-reader system. To make the study website easy to remember and access, the e-reader system was branded as 'Sirius Reader' and care was taken to design an accessible and professional website (see Figure 5.4 and https://siriusreader.vuorinen.info/ for a preview). The appearance of the e-reader was minimally adjusted to align it with the colours used in the website design, and for example, all button colours and the progress bar were changed from dark blue to orange (see Figure 5.5). A preview site on the appearance and functionality of the e-reader system is available at https://siriusreader.vuorinen.info/reader.

Additional tracking functionality was added in the e-reader to improve the accuracy of reading behaviour measures. In the previous study, event durations were adjusted if the final closing event was missing from the tracking data, possibly due to loss of internet connectivity or abrupt closing of the browser window. To address the issue, tracking events were temporarily stored on the participants' device in case of a connection issue, and then sent to the server once connection was restored. Furthermore, a new connectivity test was added to the tracking data which was used to probe connection status every 15 seconds. These changes allowed us to compute when the participant closed the e-reader if the final closing event was missing, and as a result, it was not necessary to adjust any event durations in the current study.

To enhance the accessibility of the e-reader, participants were allowed to adjust the font size in the e-reader. Changes in font size affected how much text was visible on the screen, and to maintain the participant's current location in the text, the e-reader system refreshed the visible text and ensured that most of the text that was previously visible at the beginning of the page-view remained visible after a font re-size.

Figure 5.4

Screenshot of the E-Reader System Website Branded as 'Sirius Reader'

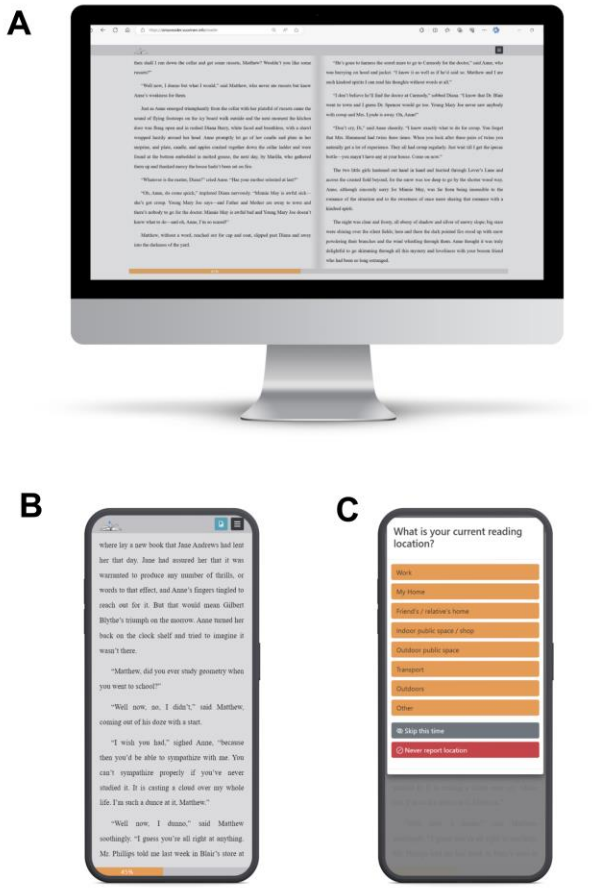
Similarly to the previous study, reading sessions that lasted for less than a minute or which consisted of less than 15% of engagement were considered to be artefacts. In total, 3044 reading sessions were categorised as artefacts, from 498 participants. The proportion of reading session artefacts was higher in the current study (48.82%), compared to the previous (20.49%). The session artefacts were more likely to be recorded on larger than smaller devices, $x(1) = 287.5$, $p < .001$. Indeed, it is possible that the artefacts were due to the participants leaving the e-reader system browser tab open on a computer, which may have been accidentally activated, for example, when the browser is opened or when the participant is cycling through other browser tabs. This would have been less common in the previous study, considering that the majority of participants read the text in one reading session.

Information on participants' reading locations was collected by self-reports. At the beginning of each reading session, participants were asked to indicate their location by selecting an option from a list (see Figure 5.5 C). Selecting 'Other' from the list allowed participants to write down a new location that was then added to their list of location options for future reading sessions. The participants could also choose to dismiss the reading location pop-up, either once or for the duration of the study. Only 14 participants selected to not provide self-reports on their reading locations.

Participants were given an infographic on their own reading behaviour at the end of the study if they passed the infographic threshold. The infographic was automatically generated based on the tracking data, and it included information on the participant's reading speed, linearity, and reading locations (see Figure 5.6 for an example of the infographic). The infographic became available once the participant had engaged in reading for longer than it would have taken them to read 70 pages of their selected book at their baseline reading speed. Once the participant passed this threshold, an unobtrusive notification icon appeared in the top-right corner of the e-reader (see Figure 5.5 B), and the participant was informed of the infographic via email. Clicking on the infographic icon opened a pop-up window that informed the participant that accepting the infographic would return the book to the Sirius Reader library, and thus they would not be able to return to read the book after viewing the infographic. If the participant wished to proceed, they were asked to confirm their selection. Alternatively, participants could remain reading the book for as long as they wished, and they could access the infographic in the e-reader and stop reading the book at any time.

Figure 5.5

Screenshots of the E-Reader System Used in Chapter 5



Note. A) Screenshot of the e-reader system on a large device, such as a laptop or PC. The image shows the slight changes done to colouring of the progress bar. B) Screenshot of the e-reader system on a small device, such as a smartphone. The unobtrusive infographic notification is visible at the top corner (blue square). C) Location prompt that was shown to participants at the beginning of each reading session. The prompt disappeared once any of the options was chosen.

Soon after the beginning of the study, feedback from participants indicated that some had not received their infographic despite having read their selected book in full. Inspection of the issue showed that some of the participants who had selected to read the shortest book in the study read it faster than their baseline speed result would predict, and thus they did not reach the infographic threshold even after finishing the book. To address the problem, the infographic threshold was dropped to 45 pages for the shortest text. In total, 16 participants were significantly affected by the issue, and thus they did not receive the infographic before finishing the book, they received it after having read a large chunk of the book (>85%), or they received the infographic notification considerably later than they would have with the updated threshold (>25 minutes). In addition to these participants, seven participants did not realise that accepting the infographic would mean that they could no longer access the book. It was important that the infographic projected a clear choice to the participants to either continue reading or finish the study, and so we pursued to make sure that participants were aware of this. However, these seven participants missed this information and accepted the infographic without knowing that they would not be able to return to the book afterwards. The 23 participants affected by the two types of issues were not excluded from the sample, however, they were not included in analyses for reading persistence.

5.2.5 Procedure

Participants registered to take part online on the study website (see Figure 5.4 for the website). After logging in, participants were first presented with an information sheet and a consent form. They were told that they would be asked to complete a reading speed test, answer four questionnaires, select a book to read from the e-reader library, and read at least 70 pages of it in the e-reader to receive an infographic. After responding to the consent form, the participants completed the baseline reading speed test in which the same 200-word segment of a public domain text was used as in Chapter 4. The reading speed test was followed by IMI-R and ART (see Figure 5.2).

After responding to the first set of questionnaires, participants could access the e-reader library (see Figure 5.3). Participants could browse and view the books in the library for as long as they wished. Once the participant confirmed their book selection they could proceed to the e-reader system. The selected book was opened in the first page of the first chapter, to mimic the functionality of popular e-readers such as Amazon Kindle. Participants were free to navigate the text and read it for however long they wished.

In the e-reader system's menu, participants could access the information sheet but also withdraw from the study or finish it early. The participants were informed that finishing the study before the infographic notification appeared allowed them to stop reading and continue to the final set of questionnaires, but no infographic on their reading behaviour would be generated.

Once the participant exceeded the infographic threshold, an unobtrusive notification appeared at the top right corner of the e-reader (see Figure 5.5 B). Clicking on the notification informed the participant that they could stop reading and finish the study to receive their infographic. Alternatively, the participants could continue reading the book for as long they wished.

After the reading phase, participants completed IMI and the questionnaire on electronic reading experience. Participants were then shown a debrief sheet with more information on the study followed by their personalised infographic (see Appendix B for the debrief sheet and Figure 5.6 for an example of the infographic).

Participants received automatic email reminders throughout the study. Reminders were sent once a week for participants outside of the main phase of the study (see Figure 5.2). Reminders during the reading phase were sent once every two weeks to avoid making the participants feel pressured to read the book. The data collection for the study lasted from August 2021 to June 2022. Active participants were informed about the end of the study in their regular reminder emails.

5.2.6 Design

Similarly to the previous study, we used a between-subjects design. The dependent variables included measures of reading frequency, persistence, task-switching frequency, reading speed, and linearity of reading. See Figure 3.6 in Chapter 3 for more information on the reading behaviour measures. Independent variables for reader characteristics models included situational and contextual motivation, print exposure, and TR-EEXP, whereas independent variables for task-contexts models included measures for the timing and locations of reading sessions, location in text, and previous reading behaviour.

Figure 5.6

Example of the Reading Behaviour Infographic Used in Chapter 5.

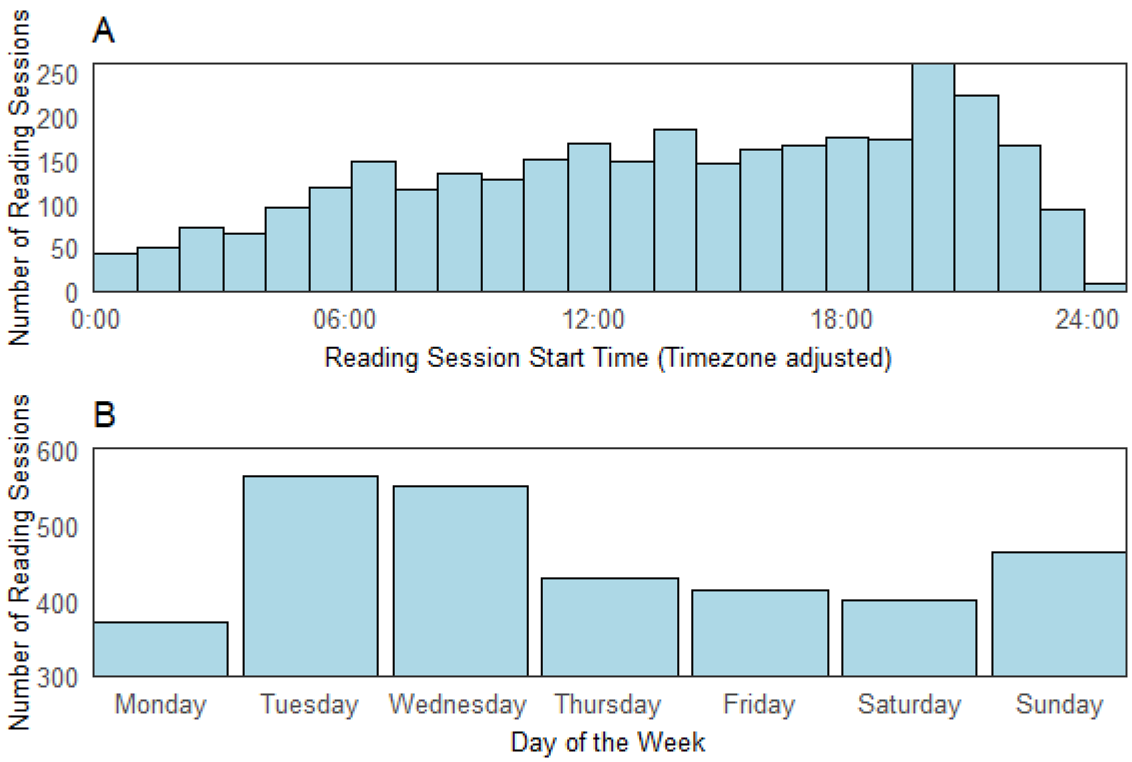
Note. The infographic shows real reading behaviour data from testing phases of the e-reader system development for Chapter 5. For a full resolution version, see https://pauliinav.github.io/Natural_e-Reading_Behaviour_Materials/Chapters/Ch5_InfographicExample.png

5.3 Results

In total, 711,445 tracking events were collected. On average, participants had 996 tracking events (*SD* = 1,664.4), and they spent 2.36 hours using the e-reader system (*SD* = 2.86 hours). The majority of events were recorded on small devices (82.6%), such as a smartphone, on which text was shown in one column. Reading location reports showed that the majority of reading sessions occurred at home (78.36%), followed by work or school at 5.17% of the time, and transport or commute at 4.93%. Reading sessions occurred most often in the evenings and early on in the week (see Figure 5.7).

Figure 5.7

Variance in Reading Session Timings Across (A) Times of the Day, and (B) Weekdays



The majority of participants indicated that the state of the COVID-19 pandemic was 'moderate' in their location at the time of participation. Most participants reported spending more time at home due to COVID-19 (79.8%), but the majority indicated that they do not have more spare time due to the pandemic (56.2%). 44.9% believed that COVID-19 had influenced their reading habits, and inspection of the most common words in the participants' explanations showed that reading engagement was affected by changes in available free time, working habits or the lack of a commute, and difficulty concentrating on reading. Therefore, the participants' reading behaviour may have been influenced by the COVID-19 pandemic, and so the results may not generalise to adults' reading behaviour outside of the pandemic.

5.3.1 Reading Motivation

Findings from IMI-R showed that participants were highly contextually motivated to read recreationally (see Table 5.4). Participants reported that they read for pleasure, on average, a few times a week (M = 4.38, SD = .74). Participants' contextual motivation score was significantly positively correlated with their recreational reading frequency, r = .553, $p < .0001$. On the other hand, frequency of reading for school or work was slightly negatively associated with contextual reading motivation, r = -.084, p = .023.

Findings from ART showed that participants selected on average 37.9 author names (SD = 21.8), of which 98.1% were real authors. Print exposure was positively correlated with contextual interest, r = .300, $p < .0001$, indicating that participants who reported enjoying reading for pleasure also recognised more author names.

Situational motivation was assessed at the end of the study by IMI. The results showed that, on average, participants enjoyed the book that they read during the study (see Table 5.4). Situational motivation was positively associated with situational competence and autonomy scores, r = .36-.53, $p < .001$, showing that participants who enjoyed the book were also likely to feel autonomous and competent in reading it. Furthermore, situational motivation was significantly correlated with participants' contextual motivation, r = .21, $p < .0001$, indicating that participants who enjoyed their selected book were motivated to read contextually as well.

5.3.2 Electronic Reading Experience

The majority of the participants indicated that they enjoy reading both ebooks and print books (38.7%, n = 171), or all three reading formats surveyed - print, ebook, and audiobook (24.2%, n = 107). A print preference was reported by only 20.6% of the participants, and 10.4% of the participants indicated that they prefer to read electronically.

On average, the participants had access to 3.2 different digital devices (*SD* = 1.2). Most of the participants had a smartphone (91%), a laptop (74%), and a tablet computer (60%). Furthermore, the majority of participants had access to a dedicated e-reader (57%).

Despite the participants having access to several electronic devices, they reported reading print books most frequently (on a 5-point scale: $M = 3.5$, $SD = 1.1$). Smartphones and dedicated e-ink e-readers were the most frequently used digital reading formats, with participants using them on average ‘a few times a month’ ($M_{smartphone} = 3.1$, $SD_{smartphone} = 1.5$, $M_{e\text{-}reader} = 2.6$, $SD_{e\text{-}reader} = 1.6$). Digital devices were used to read fiction books and newspaper articles on average ‘a few times a month’ ($M_{books} = 3.4$, $SD_{books} = 1.4$, $M_{newspaper} = 3.5$, $SD_{newspaper} = 1.4$), whereas other text types, such as short stories, nonfiction books, or textbooks, were read a few times a year or never.

Scores on TR-EEXP showed that participants read task-relevant text types electronically on average ‘a few times a month’, whereas task-relevant devices were used for recreational reading purposes only ‘a few times a year’ (see Table 5.4). This indicates that participants have some experience with task-relevant text types, however, they may be mostly reading them on devices that could not be used in the current study, such as dedicated e-ink e-readers.

Table 5.4

Descriptive Results on Questionnaires and Reading Behaviour Measures in Chapter 5

		Min-Max	*Mean (SD)*
Situational motivation			
	Interest	1-7	5.9 (1.1)
	Competence	1-7	5.6 (1)
	Autonomy	1-7	6.3 (.83)
Contextual motivation			
	Interest	1-7	6.3 (.69)
	Competence	1-7	5.7 (.93)
Print exposure			
	ART score	0-99	35.5 (20.3)
Electronic reading experience			
	Task-relevant text types	1-5	2.7 (.92)

	Task-relevant digital devices	1-5	2.2 (.76)
Reading behaviour			
	Persistence: Proximity to infographic threshold (min)	-165.7-1,197.1	83.7 (170.4)
	Frequency: Time between reading sessions (hours)	0-6,929.6	81.7 (322.3)
	Task-switching: Continuous engagement duration (min)	.25-281.5	9.7 (13.3)
	Speed: Reading rate (speed/baseline speed)	.14-2.4	1.2 (.43)
	Linearity: Proportion of events initiating nonlinearity (%)	0-64.3	10.9 (8.3)

5.3.3 Reading Behaviour

To address our hypotheses, reading behaviour was studied by reader characteristics models described in Chapter 3. Unlike in the previous study, however, we conducted two separate reader characteristics models to separately assess reading behaviour of participants who did and did not complete the study in full. The first reader characteristics model included the full sample of participants (*n* = 729) but only a subset of predictors, whereas the second version of the model included only the participants who finished the study in full (*n* = 445) and all predictors. Considering that only 61% of the participants finished the study in full, limiting our analyses to the second model would have resulted in a loss of 284 participants. The first reader characteristics model included only predictors that were obtained from the first set of questionnaires (see Table 5.5 for a comparison of the models). However, as 39% participants did not reach the second set of questionnaires in the study, we could not control for the influence of situational motivation and task-relevant electronic experience in the first reader characteristics model. The second reader characteristics model followed the model structure set out in Chapter 3 with the addition of ‘feedback type’, print exposure score, and an interaction between TR-EEXP measures and age as fixed effect variables (see Table 5.5). The first variable was added to the model to control for the effect of any issues in using the e-reader system on reading behaviour. An interaction between age and TR-EEXP, on the other hand, was added to control for the possibility that participants’ age influenced their reading behaviour via TR-EEXP. Previous studies have suggested that older adults tend to have less experience in using digital devices (e.g., Vroman et al., 2015), and thus it is plausible that they would show different electronic reading behaviour in relation to task-relevant electronic reading experience, compared to younger participants. To address our hypotheses on contextual motivation (H1.2a-H1.2e), we inspect both the complete sample and the full predictor reader characteristics models, whereas hypotheses on situational motivation and TR-EEXP (H1.1a-H1.1e and H1.3a-H1.3e) could be addressed with the full predictor model only.

In addition to reader characteristics, reading behaviour was modelled by task-contexts to study how behaviour varied in relation to the context of the reading task. The model was not conducted for reading persistence due to the circular connection between persistence and many of the task-context predictors, such as location in text (see more detail in Chapter 3 Data Analysis Approach: The Task-context Models). For more information on each of the models and their structure, see Appendix D.

Table 5.5

Comparison of Multilevel Models Used to Analyse Reading Behaviour

	First reader characteristics model	Second reader characteristics model
Type	Full sample, subset of predictors	Subset of sample, all predictors
n	729*	445*
Fixed effects	1. Theoretical interest: a. Contextual motivation b. Print exposure 2. Control variables: a. Contextual competence b. Device size c. Timing of participation d. Demographics	1. Theoretical interest: a. Situational motivation b. Contextual motivation c. Task-relevant electronic experience (TR-EEXP) d. Situational competence e. Print exposure 2. Control variables: a. Contextual competence b. Device size c. Timing of participation d. Demographics e. Feedback
Random effects	(1 | Participant indicator) + (1 | Text indicator)	(1 | Participant indicator) + (1 + Situational motivation + Contextual motivation + TR-EEXP | Text indicator)

Note.
* Approximate sample size in each reader characteristics model. The real value varied between different reading behaviours depending on exclusions. See Appendix E for more information.

5.3.3.1 Reading Frequency

On average, participants had 4.5 reading sessions during the study (*SD* = 5, *range* = 1 - 36). The reading sessions lasted on average for 47 minutes (*SD* = 54.3) with participants spending up to 6.1 hours reading the book in one sitting. On average, 73.6% of reading sessions were spent engaged in reading (*SD* = 26.7%). The reading sessions occurred on average every 3.4 days (see Table 5.4). This time in between reading sessions was used as a measure of reading frequency: whereas little time between sessions was used as an indicator of a high reading frequency, infrequent reading engagement was indicated by a longer time between sessions.

Findings from the first (full sample) reader characteristics model showed that participants who completed the study read their selected book more frequently compared to participants who did not finish the study (see Table 5.6). This indicates that the two samples used in the reader characteristics models differed from each other, and so both models were retained in the analysis.

We expected reading frequency to be connected to participants' situational and contextual motivation (H1.1b and H1.2b), and TR-EEXP (H1.3b). Findings from the second reader characteristics model (subset of sample) showed that situational motivation was not a significant predictor of participants' reading frequency (see Table 5.6), contrary to our expectations. Instead, situational competence, reflective of perceived text difficulty, was connected to frequency (see Table 5.6). The main effect indicated that participants who found the text easier to read returned to it more frequently.

In contrast, contextual motivation was a significant predictor of reading frequency, supporting our hypothesis H1.2b. The finding showed that more autonomous contextual motivation was associated with higher reading frequency, indicating that readers who were generally motivated to read for pleasure returned to the book frequently. The finding was not, however, echoed in the full sample reader characteristics model (see Table 5.6). Although the direction of the effect was similar in the two models, the main effect failed to reach significance in the first reader characteristics model (p = .076). Print exposure, on the other hand, was not associated with reading frequency in either of the models.

TR-EEXP was expected to contribute positively to reading frequency if familiarity with the reading platform supports engagement and motivation for reading electronically (H1.3b).

In contrast to our expectations, however, an interaction between the task-relevant experience measures was not a significant predictor of reading frequency (see Table 5.6). Furthermore, neither of the TR-EEXP variables was individually connected to it, indicating that reading frequency was not associated with participants' task-relevant electronic reading experience.

Finally, contextual competence arose as a significant predictor of reading frequency in the second reader characteristics model (see Table 5.6). Interestingly, the main effect showed that participants' who reported a stronger reading skill read the book less frequently. However, the effect was not found in the first reader characteristics model.

In addition to reader characteristics, reading frequency was modelled by task-context. Inspection of the model showed that inclusion of reading frequency at $Event_{k-1}$ and $Event_{k-2}$ as fixed effects would have resulted in considerable data loss (35.6%) as observations were missing for each participants' first two reading frequency records ($Event_{k-1}$ could not be captured if $k < 2$ and $Event_{k-2}$ could not be captured if $k < 3$, see more detail in Chapter 3, Data Analysis Approach: Task-context Model). To prevent data loss, these fixed effects were removed from the task-contexts model, and so we could not study the effect of previous events on participants' reading frequency.

We expected a higher reading frequency to be connected to reading locations outside of the home (H2.1a). Although reading location was a significant predictor in the model (see Table 5.8), the effect was not in the direction we hypothesised. Participants returned to the book equally often regardless of whether they were reading the book at home or not. Instead, the effect was driven by a difference between participants who did or did not provide location reports: those who did not wish to report on their reading location read the book more frequently compared to those who provided location reports. It is possible that the participants who returned to the book often felt fatigued by the location report pop-ups, and thus decided to disable them. It is important to note, however, that only 14 participants decided to skip the location reports, and thus the effect is likely to be driven by a few outliers.

The model results showed that reading frequency could be predicted by timing of reading sessions and location in text (see Table 5.8). The first result showed that participants returned to their selected book more frequently at the beginning of the study recruitment period and in early reading sessions. This suggests that participants read the book more frequently early on in the study – an effect that may have been driven by some of the participants becoming disinterested in their selected text over time. Location in text, on the other hand, was positively associated with reading frequency, indicating that participants returned to the e-reader system more frequently towards the end of the book. These main effects were qualified by a significant interaction between reading session number and location in text (see Table 5.8). The interaction showed that participants read the book more frequently towards the end of the text, however, reading session number influenced reading frequency at the beginning of the text: participants who were at the beginning of the text in later reading sessions read the book less often compared to participants who were at the beginning in early reading sessions. In other words, participants who took multiple reading sessions to read past the beginning of the text read the book less frequently, compared to participants who read further in the text in early reading sessions.

Lastly, a significant interaction effect between reading location and location in text showed that participants' reading frequency increased towards the end of the text, but only for the participants who provided reading location reports (see Table 5.8). In contrast, those who chose not to report on their location retained a stable reading frequency regardless of their location in text.

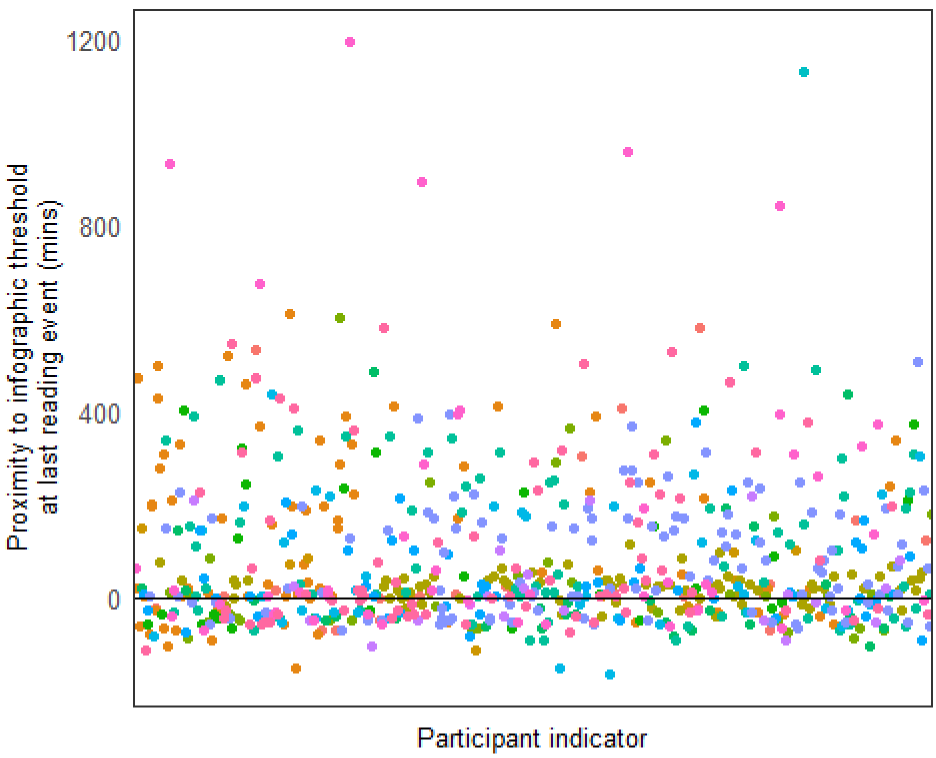
5.3.3.2 Reading Persistence

On average, participants read their selected book until 53.1% of the way through, and in total, 41.8% of the participants read at least 90% of the book. 65.9% of the participants reached the infographic threshold, and thus they were given an opportunity to stop reading the book and finish the study. Of these participants, 20.8% stopped reading their selected book within 15 minutes of the notification, whereas the remaining 79.2% continued for longer. On average, participants read the book for 83.7 minutes after the infographic notification appeared (see Table 5.4). We used the time from the infographic threshold as a measure of reading persistence. This *proximity to infographic threshold* at last reading event allowed us to capture for how long participants continued reading the book after the infographic became available, or how far away from the threshold they were at the end of the study (see Figure 5.8). Therefore, the measure provided more nuance than a binary indicator of whether the infographic threshold was reached or not.

The reader characteristics models for reading persistence were slightly modified. Considering that persistence was only measured once for each participant, it was not possible to include a random effect of participant indicator in the models. Instead, only random variation of book was estimated. Furthermore, any participants who did not receive the infographic notification as intended (*n* = 16, see more information in Method: Participants) and those who did not realise that they could not continue reading the book after accepting the infographic (*n* = 7), were removed from the persistence analysis. Finally, the control variable for whether participants reached the infographic threshold or not was not included in models for reading persistence. This is because the reading persistence measure was collinear with the binary indicator of whether the study was completed or not. As a result, it would not have been meaningful to include the variable in the models. See Appendix D for more information on each of the models.

Figure 5.8

Variance in Reading Persistence as Measured by Proximity to Infographic Threshold.



Note. Proximity to infographic threshold is measured as distance from the infographic threshold in minutes on each participants' last reading event. The horizontal line shows the infographic notification threshold, and so participants below the line did not reach the infographic.

We expected participants' contextual and situational reading motivation to be connected to their reading persistence (H1.1a and H1.2a). Indeed, situational motivation was a significant predictor of persistence in the second reader characteristics model (see Table 5.6), supporting our hypothesis H1.1a. The finding showed that participants who were more autonomously motivated to read their selected book persisted in reading it for longer. Additionally, perceived autonomy score was significantly associated with persistence (see Table 5.6), indicating that participants who felt more autonomous in text selection were more likely to persist in reading the book. Similarly, more autonomous contextual motivation was expected to be connected to higher reading persistence, however, contextual motivation was not connected to persistence in either of the reader characteristics models.

Although contextual motivation score from the IMI-R was not associated with persistence, findings from the first model showed that print exposure was significantly connected to it (see Table 5.6). This suggests that participants who correctly recognised more author names were more likely continue reading their selected book for longer. The finding was not replicated in the second reader characteristics model, indicating that ART score made a difference in the beginning of the book, but not thereafter. Indeed, participants who completed the study recognised significantly more authors compared to those who stopped reading prematurely, $t(580) = -4.526$, $p < .0001$.

Furthermore, we expected reading persistence to be connected to TR-EEXP (H1.3a). However, our hypothesis was not supported as the interaction between the two TR-EEXP measures was not a significant predictor of reading persistence (see Table 5.6). Instead, a main effect of task-relevant text types was a significant predictor in the model (see Table 5.6). Interestingly, the effect showed that participants with more experience in reading task-relevant text types electronically were less likely to persist in reading the text. On the other hand, no connection was found between persistence and experience using task-relevant digital devices for recreational reading.

Additionally, reading persistence was significantly predicted by timing of participation and native language in full-sample reader characteristics model (see Table 5.6). Whereas the first finding showed that the likelihood of reaching the infographic threshold increased towards the end of the participation period, the second indicated that non-native English speakers were less likely to persist in reading the book. Interestingly, these findings were not replicated in the second reader characteristics model. Instead, findings from the second model showed that persistence was associated with participants' contextual competence score and whether they provided feedback on the functionality of the e-reader system or not (see Table 5.6). The first finding showed that a high score in contextual competence was connected to lower persistence, indicating that participants who perceived themselves to be highly competent in reading were less likely to persist in reading their selected book. It is possible that the effect was due to the highly competent readers' generally high reading speed: if these individuals read the text faster, they could have finished the book in less time and thus they would have been 'closer' to the infographic threshold in their last reading event compared to slower readers. The second finding, on the other hand, indicated that participants who reported difficulties in using the e-reader system were more likely to persist in reading the book. This seems surprising at first, however, it is possible that the participants who persisted for longer were more likely to encounter issues in the e-reader system, or the issues caused the readers to struggle with the e-reader system, and thus they took longer to finish reading their selected book. Alternatively, participants who provided feedback may have been more invested in the study, which could have both supported their persistence and encouraged them to contribute with feedback.

Table 5.6

Results from Reader Characteristics Models of Reading Frequency and Reading Persistence

	Reading Persistence				Reading Frequency			
	Model 1		Model 2		Model 1		Model 2	
	b	*SE*	*b*	*SE*	*b*	*SE*	*b*	*SE*
Fixed effect								
Intercept	5.318***	.075	5.807***	.087	7.339***	.342	6.537***	.347
Completed study (binary)					-1.274***	.161		
Window width	-.032	.021	-.012	.020	.008	.053	-.008	.058
Days until reading deadline	-.046*	.021	-.032	.019	-.215***	.059	-.091	.065
Age	.053*	.025	.031	.024	-.106	.071	-.094	.085
Gender: M vs F	-.135*	.064	-.081	.067	-.251	.204	-.155	.242
Gender: M/F vs Other	-.087	.163	-.020	.175	.381	.915	.063	.892
English as a native language (binary)	.014	.056	-.066	.053	-.031	.170	.038	.189
Education: Tertiary vs Lower	.022	.075	-.135	.071	-.373	.225	-.198	.253
Feedback provided (binary)			-.159**	.049			.166	.161

Situational interest (SINT)			.071**	.025			-.039	.086
Situational competence (SCOMP)			.023	.027			-.212*	.094
Situational autonomy			.089***	.022			-.023	.075
Contextual interest (CINT)	.039	.026	.003	.024	-.136	.077	-.190*	.086
Contextual competence	-.069**	.026	-.076**	.027	.093	.084	.230*	.104
Print exposure (ART)	.050*	.025	-.009	.022	.093	.074	.027	.079
TR-EEXP1: Task-relevant text types			-.069**	.022			.077	.077
TR-EEXP2: Task-relevant digital devices			-.008	.020			-.098	.074
TR-EEXP1 x TR-EEXP2			-.022	.021			-.094	.072
TR-EEXP1 x TR-EEXP2 x Age			-.008	.018			.019	.063
Random effect	*Variance*	*SD*	*Variance*	*SD*	*Variance*	*SD*	*Variance*	*SD*
Subject indicator					1.119	1.058	.989	.994
Short story indicator	.012	.110	.029	.171	.020	.140	.058	.242
TR-EEXP1 x TR-EEXP2 (slope)			.001	.031				

Note. See Table 5.5 for information on the two different reader characteristics model types. Continuous variables have been centred around the mean, and categorical predictors were given Helmert contrasts. See Appendix D for detailed information about the models. *b* = coefficient, *SE* = standard error, *SD* = standard deviation,'*': $p < .05$,'**': $p < .01$,'***': $p < .001$

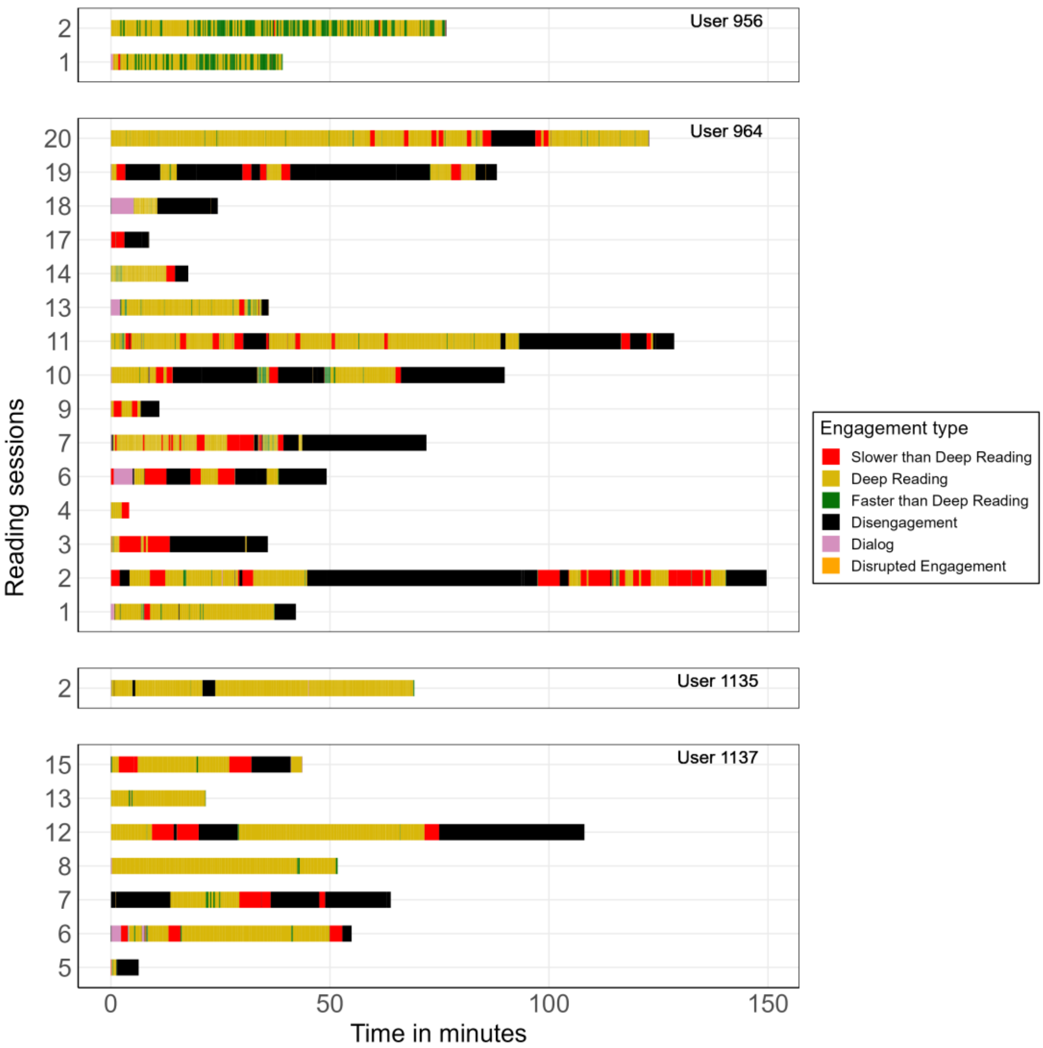
5.3.3.3 Task-switching

Task-switching during reading was common, and on average, participants disengaged from the text 4.3 times within a reading session (*SD* = 5, *range* = 1 - 92). Similarly to the previous study, continuous engagement duration was used as a measure of task-switching frequency (see Figure 3.6 in Chapter 3). Whereas a longer continuous engagement duration was taken as an indication of infrequent task-switching, frequent disengagements from the text were expected to be reflected in the data as short continuous engagements. In total, the participants had 1-149 continuous engagement blocks during the study (*M* = 14.4, *SD* =

17.8), and on average, continuous engagement lasted only for 9.7 minutes (see Table 5.4 and Figure 5.9).

Figure 5.9

Four Participants' Reading Session Timelines



Note. Each participant is shown in their own section/facet. The y-axis indicates the reading session number whereas the x-axis shows time since the beginning of the session. The colours refer to different engagement types. 'Dialog' engagement type indicates that the participant was viewing the menu or the information sheet. Where the reading session indicators are not consecutive, reading sessions that were identified as artefacts have been removed.

Both reader characteristics models were found to have a nonnormal distribution in the random effect of book indicator. Inspection of qqplots showed an outlier: the shortest book included in the study had a significantly higher concentration of low continuous engagement durations compared to the other texts included in the study, $F(15, 1.027) = 15.227$, $p < .0001$. To avoid losing data from participants who read the book, book indicator was fit as a fixed rather than a random effect. Furthermore, both models were found to be heteroscedastic. The heteroscedasticity was successfully addressed in the second, full predictor model with a box-cox transformation of the outcome variable. However, the first, full sample model was not improved by the transformation. This compromises our ability to make predictions on the basis of the models, however, this was considered to be an acceptable limitation as our objective is to primarily understand variance in the current sample rather than make predictions outside of the sample observations.

Similarly to reading frequency, findings from the full-sample model of reader characteristics showed that participants who completed the study differed from those who dropped out prematurely. The effect showed that participants who finished the study had significantly longer continuous engagement durations, indicating that they task-switched less often than participants who did not complete the study (see Table 5.7). Accordingly, both reader characteristics models were retained in analyses.

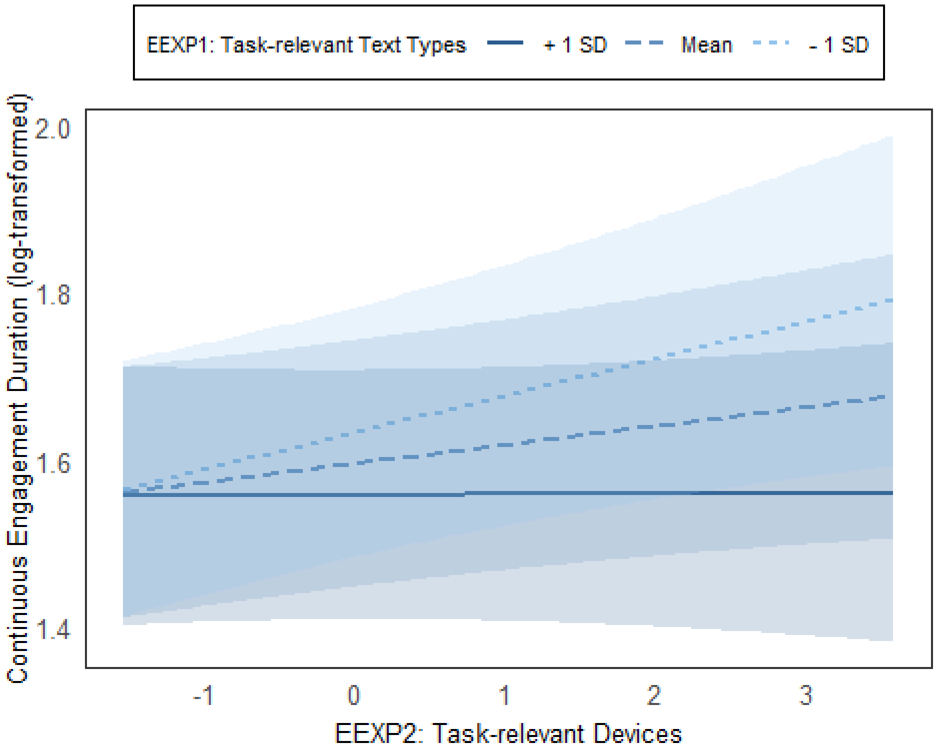
We expected participants' contextual and situational motivation to be connected to their task-switching frequency (H1.1c and H1.2c). However, in contrast to our predictions, motivation on the situational or contextual levels was not a significant predictor of continuous engagement durations (see Table 5.7). This indicates that participants' motivation towards reading or their selected book was not connected to their frequency of disengaging from the text. Similarly, print exposure was not associated with task-switching frequency (see Table 5.7).

Furthermore, we expected TR-EEXP to be connected to longer continuous engagement durations (H1.3c). Indeed, an interaction between the two TR-EEXP measures was a significant predictor of task-switching frequency (see Table 5.7). However, the findings were not in line with our expectations: participants with experience in using task-relevant digital devices for e-reading but little experience of reading task-relevant text types electronically were least likely to task-switch (see Figure 5.10), whereas we expected a combination of the two TR-EEXP measures to be positive associated with longer continuous engagements. The finding was also reflected in two significant main effects as experience with task-relevant text types was connected to more frequent task-switching, whereas experience using task-relevant digital devices for electronic reading was associated with infrequent task-switching (see Table 5.7).

Finally, task-switching frequency was significantly connected to participants' age in both reader characteristics models (see Table 5.7). The finding showed that older participants engaged continuously for longer than younger participants. Interestingly, an interaction between age and electronic reading experience was not associated with task-switching, suggesting that age contributed to the model independently from TR-EEXP.

Figure 5.10

The Effect of TR-EEXP on Task-switching Frequency



Note. The lines show the model fit and the shaded areas show 95% confidence interval. TR-EEXP (Task-relevant Electronic Reading Experience) is measured by two measures: EEXP1 shows frequency of reading task-relevant text types electronically, and EEXP2 shows frequency of using task-relevant digital devices for recreational reading. Task-switching frequency was measured by continuous engagement duration, and so larger values represent less frequent task-switching. The outcome variable is log-transformed. The predictors were centred around the mean and scaled.

Table 5.7

Results from Reader Characteristics Models of Task-switching Frequency

	Task-switching			
	Model 1		Model 2	
	b	*SE*	*b*	*SE*
Fixed effect				
Intercept	2.109***	.074	1.615***	.071
Completed study (binary)	.267***	.042		
Window width	-.002	.013	-.011	.008
Days until reading deadline	.027	.017	.017	.011
Age	.061**	.021	.030*	.014
Gender: M vs F	-.017	.058	.025	.038
Gender: M/F vs Other	-.034	.154	.030	.105
English as a native language (binary)	.036	.048	-.004	.030
Education: Tertiary vs Lower	-.059	.064	-.016	.040
Feedback provided (binary)			.019	.025
Situational interest (SINT)			.012	.013
Situational competence (SCOMP)			.013	.015
Situational autonomy			.009	.011
Contextual interest (CINT)	.006	.021	.004	.013
Contextual competence	-.016	.023	-.003	.016
Print exposure (ART)	.009	.021	.012	.012
TR-EEXP1: Task-relevant text types			-.038**	.012
TR-EEXP2: Task-relevant digital devices			.022*	.011
TR-EEXP1 x TR-EEXP2			-.021*	.011
TR-EEXP1 x TR-EEXP2 x Age			-.009	.010
Book 1	-.115	.108	-.047	.065
Book 2	.161	.176	.085	.113
Book 3	-.448***	.083	-.210**	.065
Book 4	-.005	.098	-.008	.080
Book 5	.155	.106	.042	.082
Book 6	.083	.102	.005	.100
Book 7	.009	.064	-.030	.065

Book 8	.291	.373	.031	.075
Book 9	.049	.095	-.038	.073
Book 10	-.036	.083	.015	.063
Book 11	.038	.062		
Book 12	-.045	.114	-.072	.089
Book 13	-.190	.481	-.004	.257
Book 14	.085	.084	.035	.071
Book 15	-.021	.073	-.043	.070
Random effect	*Variance*	*SD*	*Variance*	*SD*
User indicator	.128	.358	.032	.178

Note. See Table 5.5 for information on the two different reader characteristics model types. Continuous variables have been centred around the mean, and categorical predictors were given Helmert contrasts. One of the story indicators was removed from the task-switching analysis due to limited observations. *b* = coefficient, *SE* = standard error, *SD* = standard deviation,’*’: $p < .05$, ’**’: $p < .01$, ’***’: $p < .001$, See Appendix D for more detail.

Similarly to the reader characteristics models, book indicator was fit as a fixed rather than a random effect in the task-contexts model to address nonnormality of the random effect. Again, one of the books, *Cleanskin* by Val McDermid, was connected to significantly shorter continuous engagement durations. This may have been due to the book being shorter than many of the others (see Table 5.3).

We expected participants to task-switch more frequently at the beginning of the reading task (H2.2a and H2.3a) when they are still unfamiliar with the story premise and unlikely to become fully immersed in the text. Indeed, the findings showed that participants task-switched more often in early rather than late reading sessions (see Table 5.8), supporting our hypothesis H2.2a. Location in text, however, was not connected to task-switching frequency, contrary to our expectations.

Participants were also expected to task-switch more frequently at the beginning of reading sessions (H2.4a) if they struggled to settle down to read. Although time in a reading session was a significant predictor in the model (see Table 5.8), the effect was opposite than what we expected. Indeed, participants disengaged more frequently at the end of reading sessions, and so their continuous engagement durations decreased further into a reading session.

Finally, we expected task-switching to be more frequent in reading locations outside of the home (H2.2a). This hypothesis was supported as the participants who read the book at home disengaged less often compared to the participants who were reading the book outside of their home (see Table 5.8). Additionally, reading location was a significant predictor of task-switching frequency in interaction with location in text and reading session number (see Table 5.8). The first effect showed that reading location outside of the home was associated with frequent task-switching in particular towards the end of the text. Interestingly, interaction with reading session number showed the opposite pattern: reading sessions outside of the home were connected to longer continuous engagements in latter reading sessions, whereas reading at home resulted in stable continuous engagement durations regardless of the number of reading sessions.

Whereas the previously discussed reading behaviours could not be studied in relation to previous events, the predictors could be included in the task-contexts model of task-switching frequency as their inclusion resulted in only 6.9% of data loss. The findings showed that both main effects and an interaction between $Event_{k-1}$ and $Event_{k-2}$ were significant predictors of task-switching (see Table 5.8). The main effects indicated that previous continuous engagement durations were positively connected to the outcome variable, and so participants were likely to either disengage frequently or focus for extended periods at a time. Variation in task-switching frequency was not uncommon however, as the interaction effect showed that a long continuous engagement duration at $Event_{k-1}$ was more predictive of long continuous engagement duration at $Event_k$ if they followed a short continuous engagement at $Event_{k-2}$.

Table 5.8

Results from Task-contexts Models of Reading Frequency and Task-switching

		Reading Frequency		Task-Switching Frequency	
		b	*SE*	*b*	*SE*
Fixed effect					
	Intercept	6.734***	.081	2.105***	.042
	Window Width	.046	.051	.016	.014
	Days Until Reading Deadline	-.289***	.059	.035*	.017
	Event k-1			.083***	.009
	Event k-2			.068***	.010
	Reading Session Number (RSN)	.467***	.078	.054*	.024
	Time in Reading Session (TRS)			-.035*	.016
	Location in Text (LT)	-.318***	.055	-.019	.015

	Reading location: home or outside of home (RL1)	-.012	.098	-.107***	.027
	Reading location: reported or not reported (RL2)	-1.194***	.099	.050	.031
	Event k-1 x Event k-2			-.015*	.006
	RSN x TRS			.003	.016
	RSN x LT	-.167***	.036	-.008	.011
	RSN x RL1	-.103	.166	.098*	.050
	RSN x RL2	-.006	.105	-.054	.033
	TRS x LT			.006	.010
	TRS x RL1			-.012	.024
	TRS x RL2			.003	.036
	LT x RL1	-.120	.117	-.112***	.032
	LT x RL2	.424***	.099	.031	.030
	Book 1			-.073	.104
	Book 2			.316	.175
	Book 3			-.400***	.080
	Book 4			-.045	.094
	Book 5			.158	.098
	Book 6			-.100	.102
	Book 7			.093	.061
	Book 8			-.015	.310
	Book 9			.066	.090
	Book 10			-.038	.076
	Book 11			.098	.057
	Book 12			-.109	.113
	Book 13			-.714	.482
	Book 14			.063	.079
	Book 15			.060	.068
Random effect		*Variance*	*SD*	*Variance*	*SD*
	Subject indicator	1.232	1.110	.090	.300
	Book indicator	.015	.122	*FE*	*FE*

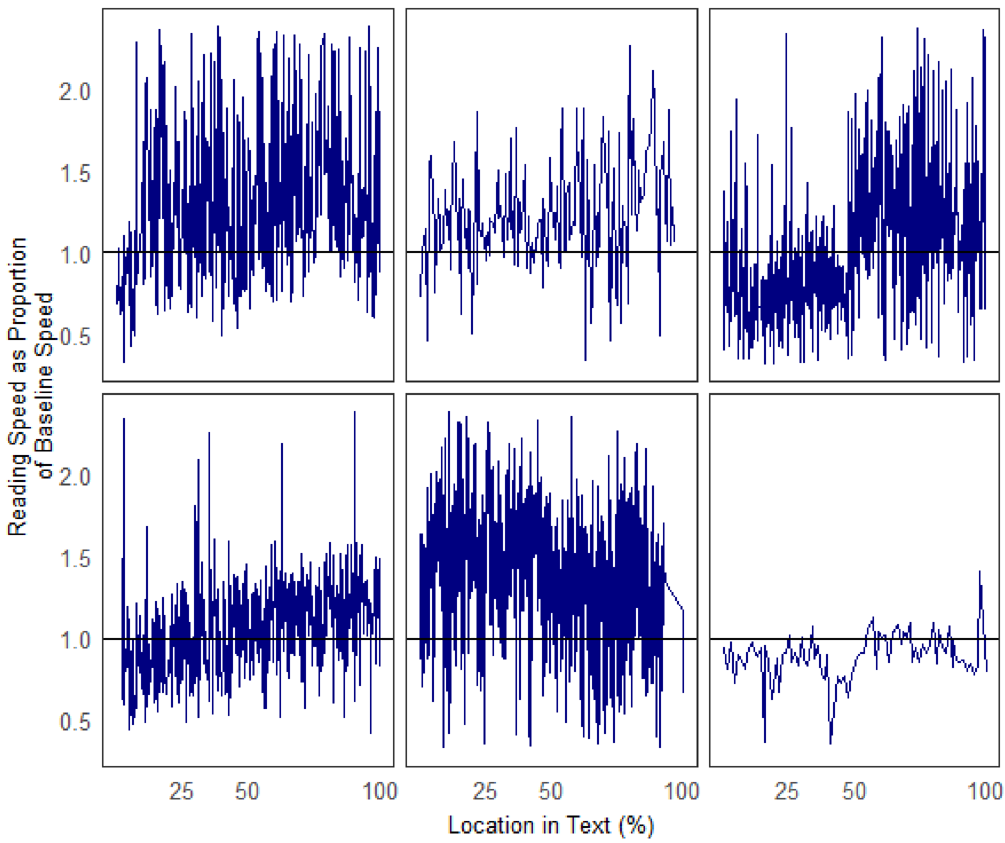
Note. Continuous variables have been centred around the mean and categorical predictors were given Helmert contrasts. Event k-1 describes the previous event, and Event k-2 shows the event preceding the previous (compared to Event k which represents the outcome variable). See Appendix D for detailed information on all models. *FE* = fit in the model as a fixed effect, *b* = coefficient, *SE* = standard error, *SD* = standard deviation, '*': $p < .05$, '**': $p < .01$,'***': $p < .001$.

5.3.3.4 Reading Speed

Participants spent most of their time in the e-reader system deep reading their selected text (*M* = 74.2%, *SD* = 20.5%). We used variance in deep reading speed in relation to the participants' baseline reading speed as a measure of reading speed (see Figure 3.6 in Chapter 3). On average, participants read the book slightly faster than their baseline (see Table 5.4), although variation was common (see Figure 5.11).

Figure 5.11

Six Random Participants' Reading Rate Variance



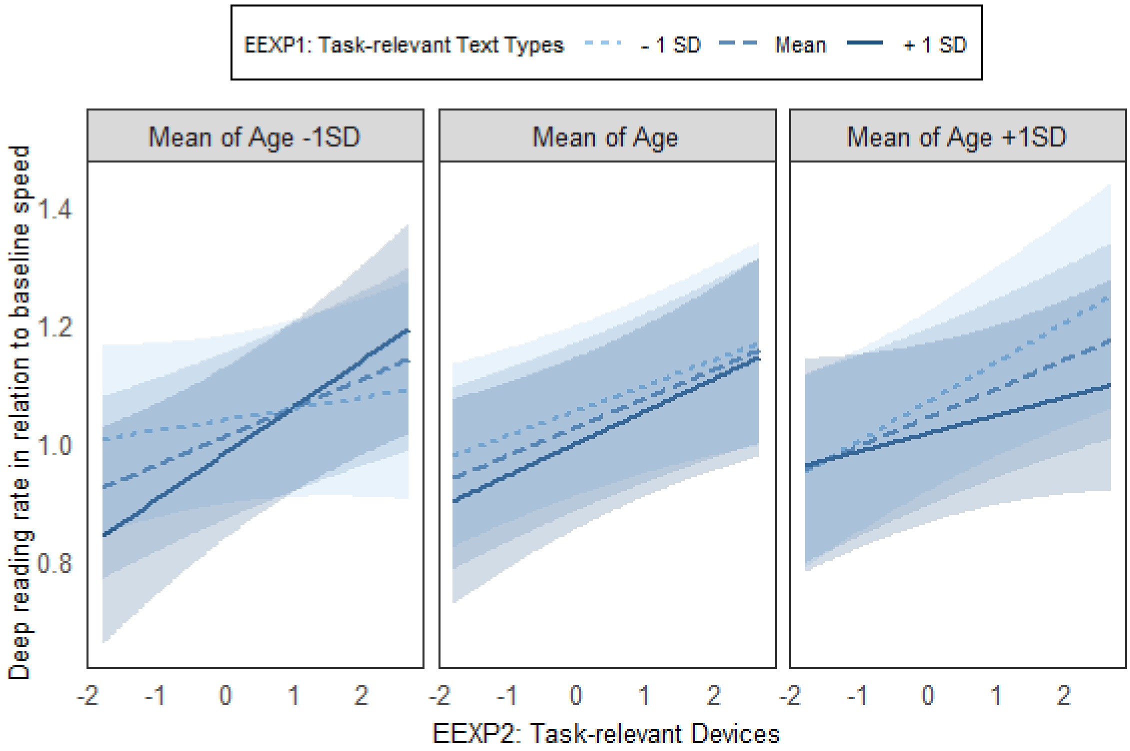
Findings from the first, full-sample reader characteristics model showed that participants who dropped out from the study differed in their reading speed from participants who completed the study (see Table 5.9). The effect showed that participants who did not finish the study used overall slower reading speeds, indicating that both reader characteristics models should be retained in the analysis.

We expected participants' reading speed variance to be connected to their situational and contextual motivation in interaction with situational competence if motivation supports the reader in reacting to text difficulty (H1.1d and H1.2d). However, these hypotheses were not supported as the interaction effects did not predict variance in participants' reading rate (see Table 5.9). Therefore, situationally or contextually motivated participants were not more likely to react to text difficulty by slowing their reading speed, contrary to our expectations. Furthermore, main effects of situational and contextual motivation were not significant predictors in either of the reader characteristics models, indicating that reading speed was not associated with the participants' reading motivation independently from text difficulty. Instead, participants' situational autonomy score was significantly connected to reading speed (see Table 5.9), showing that participants who felt more in control over the text selection procedure read their selected book at an overall slower deep reading speed.

In addition to motivation, we expected participants' reading rate to be connected to their TR-EEXP in interaction with text difficulty (H1.3d). We hypothesised that participants with more task-relevant electronic reading experience would be more deeply engaged with the text, and so they should readily adjust their reading speed if the text is perceived to be difficult. Our hypothesis was not supported, however, as the interaction was not a significant predictor in the model (see Table 5.9). Instead, reading rate was significantly connected to main effects of the two measures and an interaction between TR-EEXP and age (see Table 5.9). The main effects showed that participants with experience reading task-relevant text types electronically read the book at a higher deep reading speed compared to readers who were less used to reading narrative fiction electronically. In contrast, task-relevant device experience was connected to the opposite: participants who reported using general-purpose devices for electronic reading had a tendency to read at a slower rate. The interaction effect qualified these finding, showing that experience with task-relevant text types was positively connected to reading speed, regardless of age. Instead, the interaction effect was driven by a difference in younger and older participants' task-relevant device experience: whereas in young adults, high TR-EEXP was connected to a higher than baseline reading speed, in older adults, fast reading speed was predicted by a low level of device type experience combined with a high score in text type experience (see Figure 5.12).

Figure 5.12

The Effect of TR-EEXP and Age on Reading Speed



The findings showed that variance in reading speed was also associated with participants' demographic information. In both models, native language was significantly connected to readers' deep reading speed (see Table 5.9). The finding showed that native English speakers read the text at a faster deep reading speed compared to non-native speakers. The model findings diverged, on the other hand, on the effect of education (see Table 5.9). Whereas the full-sample model showed a significant main effect suggesting that highly educated participants read the book faster, education was not a significant predictor of reading speed in the second reader characteristics model.

Finally, reading speed was connected to control variables included in the models. Device size and study phase were associated with reading speed in both reader characteristics models (see Table 5.9). The findings showed that participants who read the book on a larger device, such as a laptop or a PC, read the text faster, compared to participants who read the text on smaller device, such as a smartphone. A main effect of study phase, on the other hand, showed that participants' reading speed increased towards the end of the recruitment period, which could have been due to pressure to finish the book in time or increasing familiarity with the writing style (see more on this in the below results on task-contexts). Furthermore, feedback on the e-reader system was a significant predictor in the second reader characteristics model (see Table 5.9). The finding showed that participants who provided feedback on the e-reader read the book at a faster deep reading speed.

Task-contexts model of reading speed was used to assess how participants' reading rate varied in relation to the reading task. We expected participants to use baseline-level and slower reading speeds at the beginning of the reading task (H2.2b and H2.3d). The findings showed that location in text was positively connected to reading speed variance, supporting our hypothesis H2.3b: participants read the beginning of the text with a slower deep reading speed, and sped up towards the end of the text. In contrast, hypothesis H2.2b was not supported as reading session number was not connected to participants' reading speed. These main effects were qualified by an interaction between reading session number and location in text (see Table 5.10), which showed that participants increased their reading rate towards the end of the text more if they were reading it in early reading sessions.

We expected participants to use slower reading speeds at the beginning of reading sessions if they struggled to settle down to read (H2.4b). The hypothesis was supported, as the main effect showed a positive association between time in a reading session and reading speed (see Table 5.10): participants had a tendency to read the book slower in the beginning of reading sessions and then speed up later on. In addition to the main effect, reading rate was significantly predicted by an interaction between time in a reading session and location in text (see Table 5.10). The finding suggested that participants who were reading the beginning of the text showed a bigger increase in their reading rate further into a session compared to participants reading latter sections of the text. It is possible that the finding reflects a combination of our expected effects in the beginning of the reading task and the beginning of a reading session.

Finally, we hypothesized that reading outside of one's home would be connected to slower reading speeds (H2.1c). However, reading rate was not significantly predicted by reading location, contrary to our expectations. Instead, reading location was a significant predictor in interaction with other variables (see Table 5.10). An interaction with location in text indicated that participants who provided location reports during study showed a more positive relationship between location in text and reading speed. However, the location report itself did not have an effect on the connection between speed and location in text. An interaction between reading location and time in a reading session, on the other hand, indicated that participants' reading rate increased further into a reading session only if their reading location was reported as 'home' rather than outside of the home.

Indicators for previous reading speeds could be included in the model as they accounted for only 0.3% of data loss. The results showed that a fast reading rate at $Event_k$ was likely to follow from previous pages ($Event_{k-1}$ and $Event_{k-2}$) that were read with an equally high speed (see Table 5.10). Furthermore, an interaction between $Event_{k-1}$ and $Event_{k-2}$ showed that $Event_k$ (the outcome variable) was more likely to include a fast deep reading speed if both previous events were similarly fast. This indicates that the participants were unlikely to vary their reading speed on consecutive pages.

5.3.3.5 Linearity of Reading

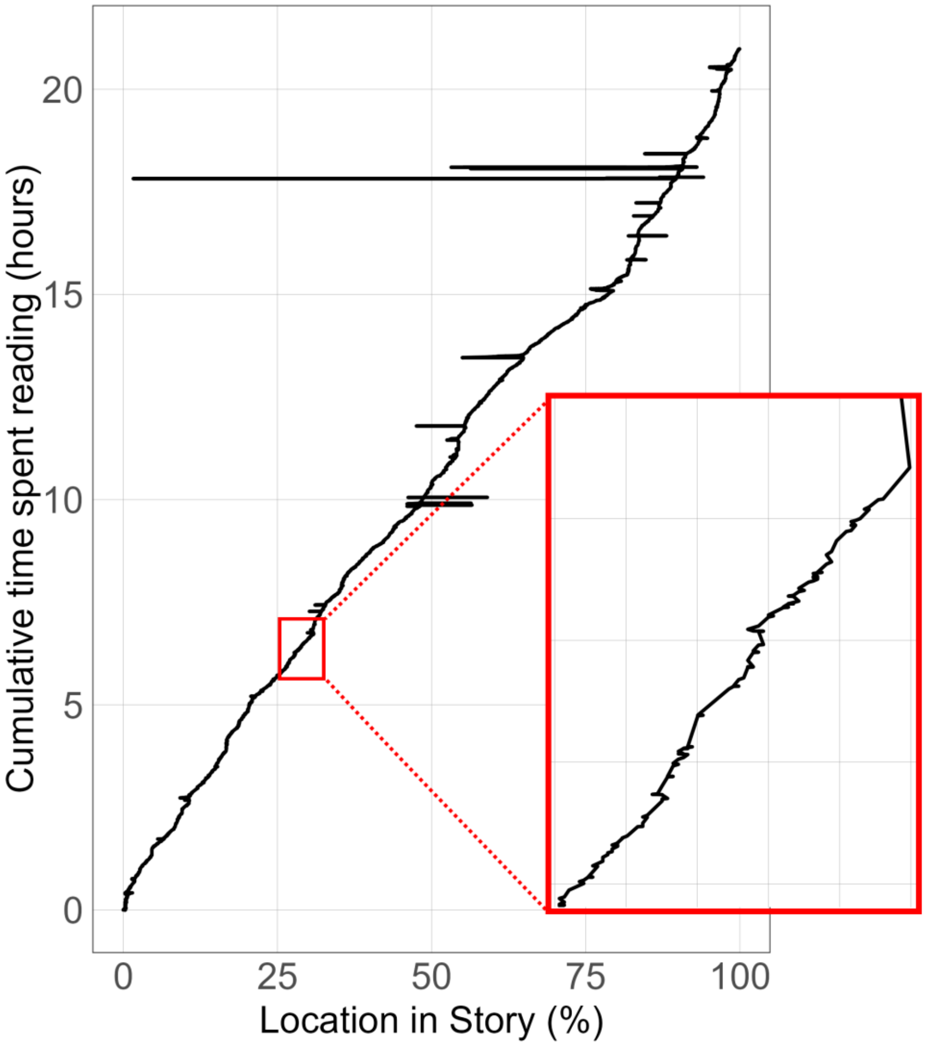
Nonlinear navigation was common during the study as, on average, 11.4% of navigation events included nonlinear navigation (see Table 5.4 for averages, and Figure 5.13 for one participant's reading process). Indeed, participants navigated the text nonlinearly 39.1 times during the study (*SD* = 62.7, *range* = 1-750). Similarly to Chapter 4, linearity of reading was measured by a binary variable indicating whether each page-view initiated nonlinear navigation or not (see Figure 3.6 in Chapter 3).

All but one participant made use of regressions during the study, and on average 95.7% of participants' nonlinear navigation consisted of movement backwards in the text (*SD* = 8.86%). Most of these regressions included a look-back to the previous page (59.5%), 14.7% of the regressions included movement two to ten pages backwards, 15.7% were used to move 11-50 pages backwards, and 2.1% ranged further than 51 pages backwards.

Forward leaps were less common, with 50.72% of participants utilising them. Those who skipped forwards in text did it on average 8.6 times during reading of the book (*SD* = 18, *range* = 1-193). The majority of forward leaps included movement up to three pages forward from the participants' most recent chronological position (55.7%), 32.2% were three to 10 pages forwards in text, and the remaining 12.2% included a leap from 11 to up to 138 pages forwards in the text.

Figure 5.13

One Participant's Reading Process.



Note. The plot shows one participant's reading process during reading of *The Rookie* by Scott Sigler. The red rectangle shows a zoomed in section of the participant's reading process from 25% to 30% of the text. Horizontal lines in the plot indicate nonlinear navigation, whereas the slope of the line shows reading speed. The zoomed-in section of the reading process illustrates how reading engagement was highly nonlinear, a pattern that is not apparent at first when looking at the full reading process.

Again, both reader characteristics models were retained in the analyses as findings from the full sample model showed that participants who did not complete the study significantly differed in their linearity of reading from those who reached the end of the study (see Table

5.9). The main effect showed that participants who did not finish the study had a tendency to use nonlinear navigation more frequently compared to the rest of the sample.

We expected participants' situational and contextual reading motivation to be connected to their nonlinear navigation frequency in interaction with situational competence (H1.1e and H1.2e). However, these hypotheses were not supported as motivation was not significantly associated with linearity of reading (see Table 5.9). Similarly, our hypothesis H1.3e on the connection between TR-EEXP, situational competence, and linearity was not supported, as the interaction was not a significant predictor in the model. Together, this indicates that participants' navigation patterns were not connected to their reading motivation or their task-relevant electronic experience, contrary to our expectations.

Instead, nonlinear navigation frequency was significantly predicted by control variables in the models. Both models showed that linearity of reading was connected to the device being used (see Table 5.9). Larger devices on which the text was shown in two columns, such as laptops or PCs, were connected to more frequent nonlinear navigation compared to smaller devices, such as smartphones. Furthermore, findings from the second model indicated that men were more likely to use nonlinear navigation during the study compared to women (see Table 5.9). However, the effect was not replicated in the full sample model. Finally, linearity of reading was significantly connected to whether participants provided feedback on the e-reader system or not (see Table 5.9). The finding showed that participants who had issues in using the e-reader used nonlinearity more often, potentially in an attempt to refresh the page and resolve any issues with layout of the text.

Table 5.9

Results from Reader Characteristics Models of Reading Speed and Linearity of Reading

	Reading Speed				Linearity of Reading			
	Model 1		Model 2		Model 1		Model 2	
	b	*SE*	*b*	*SE*	*b*	*SE*	*b*	*SE*
Fixed effect								
Intercept	1.056***	.041	1.056***	.062	-2.306***	.106	-2.512***	.122
Completed study (binary)	.048*	.022			-.219***	.055		
Window width	.010***	.002	.012***	.002	.165***	.012	.174***	.013

Days until reading deadline	-.057***	.004	-.100***	.006	.011	.019	.012	.023
Age	-.019	.012	.016	.016	-.026	.029	-.017	.034
Gender: M vs F	-.039	.032	-.007	.046	.127	.077	.216*	.094
Gender: M/F vs Other	-.056	.082	-.100	.126	-.144	.209	-.427	.250
English as a native language (binary)	.124***	.027	.111**	.037	-.123	.065	-.090	.076
Education: Tertiary vs Lower	.075*	.036	.091	.050	.057	.086	.144	.101
Feedback provided (binary)			-.071*	.032			-.190**	.063
Situational interest (SINT)			-.014	.016			-.026	.033
Situational competence (SCOMP)			-.004	.019			.017	.039
Situational autonomy			-.032*	.013			-.029	.027
Contextual interest (CINT)	.001	.011	-.002	.018	-.050	.027	-.028	.036
Contextual competence	-.013	.013	.004	.019	-.020	.029	-.023	.037
Print exposure (ART)	.016	.011	-.002	.015	-.001	.028	-.008	.031
TR-EEXP1: Task-relevant text types			.049***	.015			.005	.032
TR-EEXP2: Task-relevant digital devices			-.028*	.014			-.025	.030
TR-EEXP1 x TR-EEXP2			.006	.013			.007	.030
SINT x SCOMP			-.019	.011			.003	.027
CINT x SCOMP			.015	.012			.010	.025
TR-EEXP1 x TR-EEXP2 x SCOMP			-.021	.016			.001	.028
TR-EEXP1 x TR-EEXP2 x Age			-.024*	.012			.000	.028
Random effect	*Variance*	*SD*	*Variance*	*SD*	*Variance*	*SD*	*Variance*	SD
Subject indicator	.066	.066	.068	.068	.297	.545	.232	.482
Short story indicator	.007	.007	.015	.015	.054	.233	.057	.239
SCOMP x SINT (slope)							.003	.052
SCOMP x TR-EEXP1 x TR-EEXP2 (slope)			.001	.001				

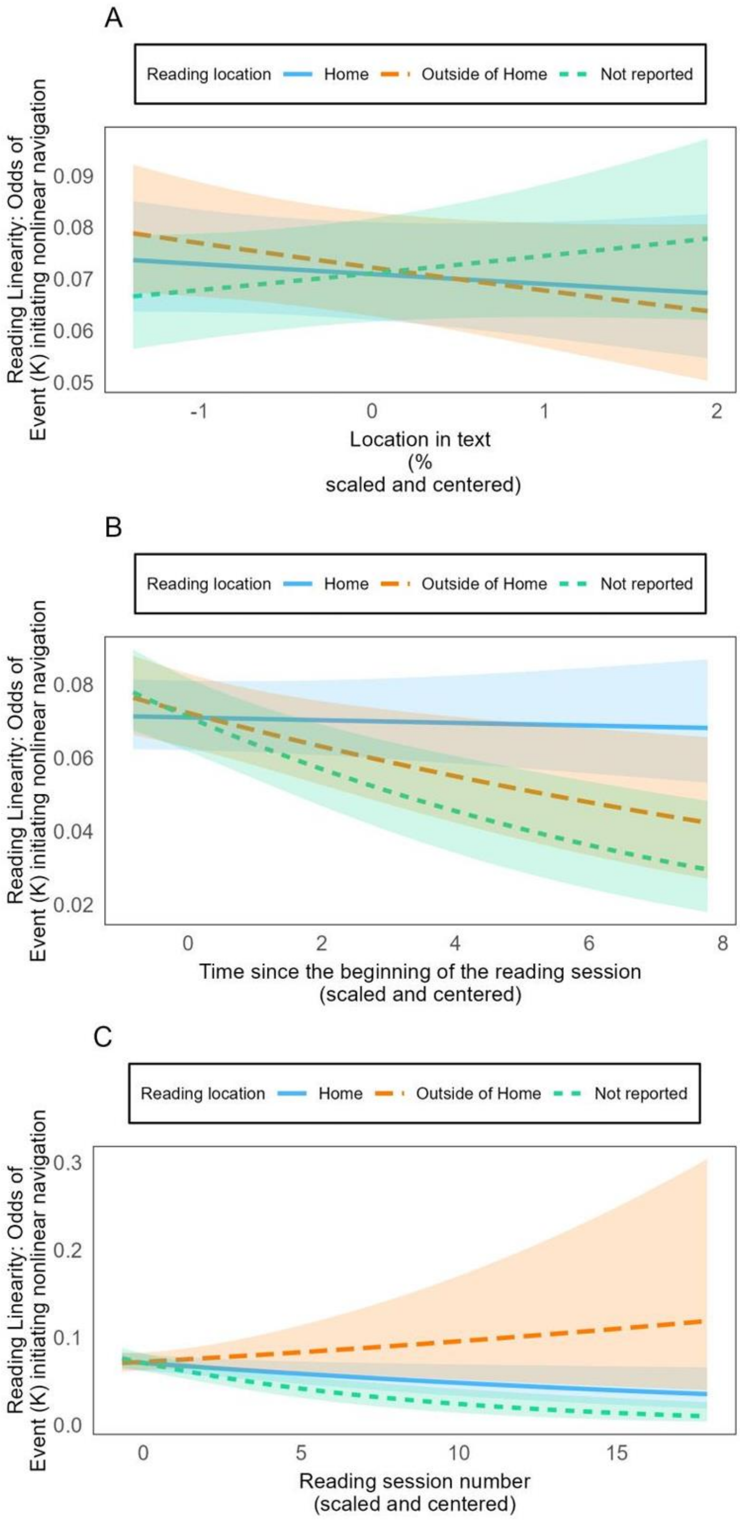
Note. Continuous variables have been centred around the mean, and categorical predictors were given Helmert contrasts. See Appendix D for more information about the models. *b* = coefficient, *SE* = standard error, *SD* = standard deviation,'*': $p < .05$,'**': $p < .01$, '***': $p < .001$.

In addition to reader characteristics, linearity was assessed in relation to the task-contexts. We expected participants to use more frequent nonlinear navigation at the beginning of the reading task (H2.2c and H2.3c). Indeed, our hypothesis H2.2c was supported as reading session number was a significant predictor of participants' navigation patterns (see Table 5.10). The main effect showed that participants used nonlinear navigation more often in early rather than late reading sessions. The main effect of location in text, on the other hand, was not a significant predictor in the model, contrary to our hypothesis H2.3c. Instead, an interaction between location in text and reading location showed that the expected effect of location in text was only observed among participants who provided location reports during the study: whereas location in text was not connected to linearity for individuals who did not wish to report on their location, participants who provided the reports were more likely to use nonlinear navigation at the beginning of the text rather than the end (see Figure 5.14A).

Similarly, we expected nonlinear navigation to be more frequent in the beginning of reading sessions (H2.4c). Indeed, a main effect of time in a reading session was a significant predictor in the model (see Table 5.10). The finding showed that participants were more likely to use nonlinear navigation in the beginning of reading sessions, supporting our hypothesis H2.4c. In addition to the main effect, time in a reading session was a significant predictor of linearity in interaction with other task-context variables: nonlinear navigation was most likely at the beginning of a reading session if the participant was reading the beginning of the text. In contrast, reading the ending of the book was connected to the opposite pattern, and so the odds of nonlinear navigation increased towards the end of the reading session. Furthermore, an interaction with reading location showed that only participants who provided location reports showed the expected pattern between time in a reading session and linearity of reading (see Table 5.10). The finding showed that participants who did not provide location reports did not vary in their linearity of reading across the reading session, whereas participants who reported on their location were more likely to use nonlinear navigation at the beginning of a reading session than the end. Additionally, a significant contrast between reported reading locations ('home' or 'outside of home') showed that participants who were reading the book at home showed a stronger connection between time in a reading session and linearity of reading (see Figure 5.14B).

Figure 5.14

The Effect of Reading Location on Linearity of Reading, in Interaction with A) Location in Text, B) Time in a Reading Session, and C) Reading Session Number



Finally, we expected participants to use nonlinear navigation more often when reading outside of the home, and thus we hypothesised that reading location should be connected to nonlinear navigation (H2.1d). However, the main effect of reading location was not a significant predictor in the model, contrary to our expectations. Instead, reading location was related to nonlinear navigation via the interactions described above (location in text and time in a reading session) and an interaction with reading sessions number (see Table 5.10). The last finding showed that reading location had no effect on linearity of reading in early reading sessions. In latter reading sessions, however, reading outside of the home was more likely to include frequent nonlinear navigation than reading at home (see Figure 5.14C).

Finally, nonlinear navigation was assessed in connection to previous events. This was possible as inclusion of $Event_{k-1}$ and $Event_{k-2}$ as predictor variables resulted in only 0.2% of data loss. The results showed that nonlinear navigation could be significantly predicted based on the previous events (see Table 5.10). The main effects showed that $Event_{k}$ was more likely to include nonlinear navigation if $Event_{k-1}$ also initiated nonlinear navigation. This could indicate participants moving back and forth in the text, for example, the reader may have jumped backwards in the text to view the introduction of a character in the first chapter, and then returned back to their most recent chronological position with a forward leap. This pattern is visible in a participant's reading process in Figure 5.13 (see the long, horizontal lines). Similarly, $Event_{k-2}$ was connected to nonlinear navigation at $Event_{k}$, showing that nonlinear navigation at $Event_{k-2}$ was predictive of nonlinearity at $Event_{k}$. These main effects were qualified by an interaction which showed that the odds of nonlinear navigation at $Event_{k}$ were the lowest if neither of the previous events included nonlinear navigation (see Table 5.10). The highest odds of nonlinear navigation, on the other hand, were associated with both of the previous events including nonlinear navigation as well.

Table 5.10

Results from Task-context Models of Reading Speed and Linearity of Reading

	Reading Speed		Linearity of Reading	
	b	*SE*	*b*	*SE*
Fixed effect				
Intercept	1.193***	.021	-1.983***	.051
Window Width	.009***	.002	.141***	.011

Days Until Reading Deadline	-.002	.011	-.001	.016
Event k-1	.079***	.001	.726***	.076
Event k-2	.045***	.001	.322***	.043
Reading Session Number (RSN)	-.021	.016	-.011	.034
Time in Reading Session (TRS)	.006***	.002	-.061***	.016
Location in Text (LT)	.033***	.002	-.025	.042
Reading location: home or outside of home (RL1)	-.006	.004	.013	.029
Reading location: reported or not reported (RL2)	-.001	.004	-.003	.032
Event k-1 x Event k-2	-.006***	.001	-.187***	.049
RSN x TRS	.002	.001	-.023	.012
RSN x LT	-.005***	.001	.016	.010
RSN x RL1	.008	.005	.066	.036
RSN x RL2	.004	.004	-.116***	.032
TRS x LT	-.011***	.001	.066***	.011
TRS x RL1	-.014***	.003	-.066*	.032
TRS x RL2	.010**	.003	-.083*	.034
LT x RL1	-.002	.004	-.044	.033
LT x RL2	-.013***	.004	.104***	.031
Random effect	*Variance*	*SD*	*Variance*	*SD*
Subject indicator	.037	.192	.072	.268
DUD (slope)	.006	.078		
Event k-1 (slope)			.525	.724
Event k-2 (slope)			.148	.385
RSN (slope)	.024	.155		
LT (slope)			.023	.150
Book indicator	.005	.068	-.011	-.097
DUD (slope)	.001	.028		
Event k-1 (slope)			.023	.176
Event k-2 (slope)			.011	.198
RSN (slope)	.002	.039		
LT (slope)			-.009	-.124

Note. Continuous variables have been centred around the mean and categorical predictors were given Helmert contrasts. Event k-1 describes the previous event, and Event k-2 shows the event preceding the previous (compared to Event k which represents the outcome variable). See Appendix D for more information on all models. *b* = coefficient, *SE* = standard error, *SD* = standard deviation, '*': $p < .05$, '**': $p < .01$,'***': $p < .001$.

5.4 Discussion

In this chapter, we studied 729 participants' reading behaviour during reading of a full-length novel. Participants were asked to read at least 70 pages of their selected book to get an infographic on their reading behaviour as compensation for taking part. This infographic threshold was used as a natural manipulation of situational motivation: we expected that participants with more autonomous motivation to read the book would be more likely to continue reading it beyond this threshold as the external pressure to complete study participation had been removed.

Similarly to Chapter 4, we expected reading behaviour to be connected to reader characteristics and task-contexts. However, the scale of the study allowed us to study behaviour beyond those assessed in the previous study; we measured participants' reading frequency, persistence, task-switching frequency, reading speed, and linearity of reading.

5.4.1 Reader Characteristics

5.4.1.1 Reading Motivation

We expected more autonomous reading motivation to support participants' reading engagement. Indeed, the findings showed that more autonomous situational motivation was connected to higher reading persistence, in accordance with our hypothesis H1.1a. Therefore, participants who were more motivated to read their selected book continued reading it for longer after the infographic notification. In contrast to our expectations, however, situational motivation was not associated with any other reading behaviours. This is surprising as previous research has connected situational motivation to frequent reading sessions (Van Ammel et al., 2021), less frequent task-switching (Ralph et al., 2021), and more adaptive adjustment of reading speed and linearity in relation to text difficulty (Maier & Richter, 2014; Milne, 2021; Rapp et al., 2007).

Interestingly, a binary indicator of whether participants reached the infographic threshold or not was connected to patterns in reading behaviour that we would have expected to see in relation to situational motivation. Participants who did not finish the study disengaged from the text more often and read the text less frequently. Furthermore, they used overall slower reading speeds and more frequent nonlinear navigation, compared to the rest of the sample. We could not measure situational motivation for participants who dropped out from the study prematurely as the IMI was included at the end of the study (see Figure 5.2). Therefore, it is possible that the participants who stopped reading before the infographic threshold were less motivated to read their selected book. Indeed, the average situational motivation score was very high, 5.9 on a 7-point scale, suggesting that the participants who made it to the end of the study were highly autonomously motivated on the situational level.

Findings on contextual motivation, on the other hand, showed that participants who were generally more motivated to read for pleasure read their selected book more frequently. This may indicate flexible reading engagement: findings by Rosenthal (1995) and Gilson et al. (2018) suggested that individuals with little contextual reading motivation view reading as a lengthy, arduous activity, whereas avid readers have reported reading in a variety of settings to fit reading for pleasure in their everyday lives (Schwabe et al., 2022).

Whereas reading frequency was significantly associated with contextual motivation, reading persistence, task-switching, reading speed, and linearity of reading were not connected to it. Therefore, we failed to replicate our findings from Chapter 4 which showed that contextual motivation was associated with infrequent task-switching, and lower reading speed if the text was perceived to be difficult to read. This discrepancy could be due to differences between the two samples: whereas in Chapter 4 the sample included undergraduate students with variable reading motivation (contextual motivation score M = 5.35, SD = .96), contextual motivation in the current study was considerably higher (6.3 on a 7-points scale). It is likely that the monetary compensation used in the previous study encouraged participants to take part regardless of their contextual motivation, whereas an infographic on participants’ reading behaviour may have primarily appealed to avid readers.

Instead of contextual motivation score from IMI-R, participants’ print exposure measured by ART was a significant predictor of their reading persistence. The finding suggests that participants who recognised more authors were more likely to continue reading the book past the infographic threshold. The effect was only observed in the full sample model, and so print exposure was not connected to persistence after the infographic had become available. However, our findings showed that participants who responded to the post-experimental questionnaires had a significantly higher score in ART, suggesting that participants with the lowest print exposure scores may have been more likely to drop out from the study prematurely.

Previous studies have suggested that print exposure is a robust predictor of contextual reading motivation (e.g., Mol & Bus, 2011). Similarly, our findings showed that participants' score in the ART was significantly, positively correlated with their contextual motivation score. Despite of this strong connection between the two measures, print exposure was found to account for variance in the mixed models independently from contextual motivation score, and the two variables were not collinear. Print exposure may, therefore, contribute to reading behaviour beyond the effect of motivation. This highlights the need for future research to examine the relationship between motivation and print exposure and their effect on behaviour.

5.4.1.2 TR-EEXP

Similarly to motivation, we expected task-relevant electronic reading experience (TR-EEXP) to support reading engagement. However, contrary to our expectations, the findings showed that a combination of the two measures, frequency of reading task-relevant text types electronically and frequency of using task-relevant digital devices for reading purposes, was not connected to reading behaviour.

Instead, the two measures of TR-EEXP predicted reading behaviour separately. The findings showed that high device experience paired with little experience reading task-relevant text types electronically was connected to infrequent task-switching. This indicates that participants who frequently use their general-purpose devices for reading texts other than narrative, long-form fiction, engaged continuously for longer compared to participants who reported reading long-form fiction on task-relevant devices, or those who had little electronic experience overall (see Figure 5.10). This is surprising because we expected that participants who are not experienced in reading long-form text electronically would struggle to focus during the reading task. This inference was made based on the shallowing hypothesis which suggests that readers can find it difficult to focus on long-form texts on digital devices that they mainly use for short-form content (Annisette & Lafreniere, 2017; Baron, 2021a).

The finding showed that both high and low TR-EEXP were connected to frequent task-switching. However, it is possible that these participants did not task-switch for the same reasons. Although short continuous engagement durations are often assumed to reflect of fragmented and distractible reading engagement, they may also tell us about intentional, flexible reading behaviour. For example, interview findings by Kosch et al. (2021) suggested that short and frequent reading sessions are a characteristic of electronic reading on the go. Whereas participants with little TR-EEXP may have felt overwhelmed by the available affordances and found it difficult to remain focused on the text, high TR-EEXP may have been associated with more ‘electronic-like’, flexible reading behaviour. Future research is needed to address this possibility by comparing task-contexts and reader characteristics within the same analysis. This was not possible in the current study with multilevel models as inclusion of so many predictors would have led to overfitting.

In addition to task-switching, experience with task-relevant text types was associated with reading persistence. The finding showed that participants with little experience of reading long-form fiction electronically were more likely to persist reading their selected book. This indicates that participants to whom the study presented a more novel experience were more likely to continue reading the text for longer, whereas those who frequently read fiction electronically were more likely to drop out from the study soon after reaching the infographic threshold. Whereas the novelty of the study may have kept unexperienced readers engaged with the text for longer, participants who regularly e-read fiction may have had access to more competing reading materials, encouraging them to move on to other e-books early in the study. Previous studies have indicated that electronic reading is characterised by low persistence due to an abundance of reading materials. For example, interviewees in a study by Kosch et al. (2021) reported that they can be picky with the books they read electronically due to the vastness of their virtual libraries. Similarly, findings by Braslavski, Likhosherstov, et al. (2016) showed that unlimited access to books in an online subscription service was characterised by low reading persistence. Accordingly, it is possible that experienced e-book readers in the current study were less invested in their selected book if they had vast collections of competing material waiting for them.

Similarly to situational motivation, our findings on TR-EEXP may have been affected by the drop-out rate. TR-EEXP was measured at the end of the study (see Figure 5.2), and so we could not capture it for participants who did not reach this point. Average TR-EEXP in the current study was higher compared to Chapter 4 (see Table 5.4 and Table 4.3 in Chapter

4), which may have been due to higher retention of electronically experienced participants. Indeed, previous studies have suggested that inexperienced users are more likely to become frustrated with the electronic platform and stop using it (Chau & Hu, 2001). However, it is possible that the study simply appealed more for electronically experienced readers, resulting in overall higher TR-EEXP scores in the sample.

5.4.2 Task-contexts

In addition to reader characteristics, we expected participants' reading behaviour to be connected to task-contexts. The findings showed that the beginning of the reading task was associated with different reading behaviour compared to the end: participants task-switched more frequently in early rather than late reading sessions, the beginning of a text was read at a slower reading speed, and nonlinear navigation was most likely in early reading sessions. These findings suggest that starting a book places different demands on the reader than continuing it later. Indeed, previous studies have indicated that readers need to familiarize themselves with the author's writing style, the story setting, and characters at the beginning of the text, which can feel arduous and overwhelming (Syd Field, 2005). With time, readers can become immersed in the narrative, which allows them to remain focused on the text for longer periods (McQuillan & Conde, 1996). As the reading task becomes less arduous, the text can be read more fluently, with a faster reading speed and more chronological reading patterns (Brysbaert, 2019; Vitu & McConkie, 2000). Similarly, participants in the current study may have found the beginning of the text more difficult to read compared to the end.

Reading behaviour was also expected to vary in relation to the timing *within* a reading session. We hypothesised that participants would struggle to settle down to read in the beginning of a reading session, which would be reflected by more frequent task-switching, slower reading speed, and frequent nonlinear navigation. Indeed, the findings showed that participants used baseline-level and slower reading speeds at the beginning of reading sessions, and then increased their reading rate further on to the reading session. Similarly, nonlinear navigation was more likely at the beginning of reading sessions, suggesting that participants may have reread previous sections of the text to remind themselves on where they left off last time. Nonlinear navigation was particularly likely at the beginning of a reading sessions if the participant was reading the beginning of the text, suggesting that nonlinear navigation may have a particularly important role at the beginning of a book. It is possible that rereading at the beginning of reading sessions becomes less important later on in the text when the reader is highly familiar with the story structure, an idea that was also suggested by self-report findings from Rosenthal (1995)[14]. Task-switching, on the other hand, was less, rather than more common at the beginning of reading sessions, in contrast to our hypothesis. This indicates that participants did not feel distractible at the beginning of new reading sessions to the extent that we expected. Instead, participants' may have grown fatigued during reading sessions, resulting in frequent task-switching towards the end of reading sessions.

Participants' reading location was measured at the beginning of each reading session by self-reports. We expected that reading outside of the home would allow participants to read the text more frequently, however, our hypothesis was not supported as reading frequency was not connected to reading location. Therefore, we found no evidence that reading on the go boosts reading frequency. This is surprising as previous studies have suggested that reading electronically on the go may supplement adults' general reading engagement (Kosch et al., 2021). In particular, avid readers have reported that they bring books with them in case they find a small pocket of time for reading (Nolan-Stinson, 2008). There are multiple possibilities for why the expected effect was not observed. First, the study was conducted during COVID-19 which may have significantly limited participants' reading location reports. In total 30.4% of the participants indicated that the COVID-19 level in their location was poor, and many of the participants pointed out that the pandemic caused them to spend more time at home. Second, our measure of reading location may have not been refined enough to see differences in reading behaviour. Due to the low variability in the location reports, we measured reading location by a binary indicator of whether location was reported as 'my home' or something else. However, the latter category may have been too wide – after all, reading in the bus during a commute is unlikely to result in similar reading behaviour as reading in a park or as an in-patient in the hospital. Finally, it is important to note that only reading frequency of one book could be inspected in the current study. In addition to the book read as part of the study, the participants may have read other texts, alternating between different reading materials.

In addition to higher reading frequency, we expected reading locations outside of the home to be more distractible than reading in the comfort of one's home. Indeed, the findings showed that task-switching was more common when the participants were reading the book

[14] One participant in Rosenthal (1995) study commented *"It usually takes me the first one hundred pages of a novel before it's set in my mind, but after that, I can jump in and out and still keep the continuity"*

outside of their home, suggesting that they may have dealt with more frequent external distractions. Furthermore, participants navigated the text more nonlinearly if they were reading it outside of their home, potentially due to the need to reread previously read sections of the text after a disengagement, as suggested by results from Chevet et al. (2022). However, this latter effect was only observed in later reading sessions. Further inspection of the data showed that reading locations outside of the home were slightly more likely to occur in later reading sessions, $t(884) = 2.250$, $p = .025$. Reading on the go can be a demanding task if the reader needs to maintain awareness of their surroundings (Kuzmičová et al., 2020), as the beginning of books have been found to be more arduous to read (Syd Field, 2005), participants may have felt more comfortable with books that they were familiar with when reading outside of their home.

Finally, we examined whether reading behaviour could be predicted by behaviour at Event_{k-1} and Event_{k-2}. Our findings showed that task-switching frequency, reading speed, and linearity of reading were connected to behaviour at these previous events. Participants were found to either engage continuously for long periods or alternate their task-switching frequency; whereas main effects of the previous events showed a positive association with continuous engagement duration at Event_{k} (the outcome variable), an interaction showed that a long continuous engagement duration was also likely to follow from a short Event_{k-2} if it was followed by a longer continuous engagement. Reading speed, on the other hand, was likely to be consistent between consecutive page-views, suggesting that any changes in reading speed was likely to be gradual. These findings echo those from Chapter 4, indicating that variance in reading speed and task-switching frequency was comparable across short story and book reading.

Linearity of reading was also connected to behaviour at previous events; however, the effect was opposite from what we observed in Chapter 4. Whereas the previous study indicated that nonlinear navigation was rarely initiated on consecutive page-views, the participants in the current study were likely to use nonlinearity consistently between page-views, either by reading consecutive pages chronologically or by initiating nonlinear navigation on each page. The latter would have required participants to navigate the text multiple pages backwards or forwards[15]. Therefore, participants in the current study may have used long-range nonlinear navigation more often compared to the previous study.

5.4.3 Limitations

The longitudinal and large-scale nature of the current study allowed us to measure reading behaviour by five different measures during reading of a full-length novel. The findings provide rich information on adults' natural reading behaviour on general-purpose devices. However, the study had its limitations.

Book reading is a demanding and time-consuming process, and accordingly, not all participants finished reading their selected book in full. This was expected, and instead of asking participants to read the book to completion, we asked them to read approximately 70 pages of it until they were given the option to view their infographic and finish the study. Our aim was to use a threshold that participants could reach while making sure that the behaviour would reflect long-form text reading. However, the threshold may have been too difficult to reach considering that only 66.3% of the participants did so. Similar and even more significant drop-out rates have been found in previous online studies, and indeed, participant retention has been recognised as a considerable issue in data collection (Nicholson et al., 2017). Considering that participants who drop out from the study prematurely may represent a different group compared to those who continue on with the study, low retention rates can bias results. We dealt with this issue by modelling variance in reader characteristics by two different models, one that included all participants regardless of whether they finished the study or not, and another that only included participants who completed the study in full. The findings showed that participants who did or did not finish the study differed in their reading behaviour, suggesting that those who dropped out from the study prematurely may have differed systematically from the rest of the sample.

As the IMI and electronic experience questionnaires were included at the end of the study, we could not measure situational motivation or TR-EEXP for participants who did not reach this point. However, it is likely that the participants systematically varied in their motivation and TR-EEXP, which may have contributed to them dropping out from the study prematurely. Whereas IMI had to be included in the study after the reading phase, TR-EEXP

[15] In contrast, a look-back to the previous page followed by a page-turn back to the most chronological position would have been recorded as nonlinearity followed by a linear event, instead of consecutive initiation of nonlinear navigation (refer to Figure 3.6 in Chapter 3 for an illustration).

was measured in the second questionnaire phase to avoid overloading participants with questionnaires in the beginning of the study.

In the previous study, we provided monetary compensation to the participants that may have influenced their situational motivation. To address this limitation, we used the infographic on participants' own reading behaviour as compensation for taking part in the current study. Findings by Deci showed that intangible rewards such as this can encourage individuals to take part without biasing their motivation. However, the infographic may have only appealed to avid readers as the current sample average indicated that participants were highly contextually motivated to read for pleasure. This limited our ability to study the effect of contextual motivation on reading behaviour.

The e-reader system allowed us to collect detailed information on reading behaviour, however, it may have had an impact on the ways in which participants read their selected text. In both the current and previous study, participants were made aware that the e-reader system collects data while it is used. This may have encouraged them to read the text in a more socially acceptable manner, by persisting reading the text for longer, task-switching less often, reading the text more linearly, and avoiding use of fast reading speeds. Indeed, previous studies have indicated that the simple knowledge of being observed can cause individuals to engage in socially desirable behaviour (Risko & Kingstone, 2011). To capture natural reading behaviour, it is important to track reading without the participants awareness.

5.5 Conclusion

This chapter built on the previous by tracking reading behaviour during reading of a full-length novel. We used bestselling books and allowed participants to select their own reading materials to enhance the ecological validity of the study. Furthermore, we incorporated a natural manipulation: participants were asked to read approximately 70 pages of their selected book before they could receive an infographic on their own reading behaviour and finish the study. Participants with more autonomous reading motivation and higher levels of task-relevant electronic reading experience were expected to be more likely to continue reading their selected book past this threshold. In line with our expectations, the findings showed that participants with more autonomous situational motivation were more likely to continue reading their selected book once they were given the option to stop. Furthermore, contextual autonomous motivation was connected to higher reading frequency and persistence, whereas the role of TR-EEXP was more ambiguous. Reading behaviour was significantly associated with a variety of task-contexts, including reading location, location in text, and timing of reading sessions.

The current study provides novel data on electronic behaviour during book reading. Due to the time commitment, very few previous studies have been able to record behaviour during reading of a full-length novel. One exception to this is Reichle et al. (2010) who used eye-tracking while participants read Jane Austen's *Sense and Sensibility* in full. Although the current study improves on Reichle et al. in terms of ecological validity, our method is not without its limitations. Participant awareness of being tracked may have caused them to behave in a more socially acceptable manner, and we were unable to measure reading behaviour on dedicated e-ink e-readers. In Chapter 6 we address these limitations by collecting a dataset of Amazon Kindle user data. This approach allowed us to measure reading behaviour across multiple different texts and on variant devices, including e-ink e-readers. Furthermore, participants had limited awareness of the tracking when the records were collected, and so the study in Chapter 6 provides a unique opportunity to study electronic reading behaviour in adults' everyday life.

Chapter 6

Reading Behaviour Across Multiple Texts on Amazon Kindle Devices

The previous studies presented in Chapter 4 and 5 examined adults' reading behaviour on general purpose devices, such as smartphones, tablets, and PCs. However, the e-reader system developed for these studies could not be accessed on one of the most popular e-reading platforms, dedicated e-ink e-readers.

According to market research by Bashir (2023), 18% of adults in the US own a dedicated e-ink e-reader. The popularity of e-ink e-readers is likely to be due to their unique features that can support reading engagement. The screen is made of electrophoretic ink that is presented on a electronic paper display that reflects rather than emits light (Comiskey et al., 1998). As a result, e-ink devices can present text with high-contrast without appearing as bright as LCD screens that are generally used in smartphones and tablets (Benedetto et al., 2013; Comiskey et al., 1998). Findings from Benedetto et al. (2013) and Zambarbieri2012 showed that electronic ink displays provide a comparable experience to reading print texts: as the visual acuity of the display is similar to paper, users rarely experience visual discomfort, such as headaches or eye fatigue, that is common when reading on LCD screens. Findings by D'Ambra et al. (2019) showed that many adults view visual discomfort as a barrier to electronic reading. As e-ink e-readers address this issue, it is likely that reading on these dedicated devices is more attractive to individuals used to print reading compared to reading on a smartphone or a PC.

General purpose devices offer abundant affordances to the user, which can pose distractions for extended reading engagement (Hillesund, 2010; Kosch et al., 2021). Dedicated e-ink e-readers, on the other hand, have few functions that go beyond reading: the user can navigate their digital library, annotate text, and purchase more reading material - however, most e-ink e-reader devices do not support web browsing or applications that are often used on smartphones. As a result, it is plausible to expect that focusing on reading on these devices is easier compared to general purpose devices. This experience was reflected by a participant in an interview study by Kosch et al. (2021):

> *"[B]efore I bought the Tolino [a type of e-ink e-reader], I also read a few e-books on my phone and I got distracted really quickly and I didn't finish reading some of them. But since I got the Tolino, I would say that I*

almost sometimes read longer on the Tolino than in a printed book.”
(p. 207)

Although e-ink e-readers do not support tasks such as messaging or using social media, they can provide features that go beyond print reading. Many e-ink e-readers have an in-built dictionary that users can access by tapping on a word (D’Ambra et al., 2019; Kosch et al., 2021). Additionally, Amazon Kindle devices have incorporated a ‘word wise’ feature that shows synonyms on top of uncommon words and an ‘X-ray’ feature that shows where in the text characters and places were previously mentioned (D’Ambra et al., 2019). These features can make reading more accessible, and support readers who struggle to comprehend a text (D’Ambra et al., 2019).

Who owns a dedicated e-reading device? Considering that these devices have few uses beyond reading, it is likely that individuals who invest in a dedicated e-reading device are highly motivated to read on the contextual level. Indeed, findings by Schwabe et al. (2022) and Zhang and Kudva (2014) showed that adults who read on e-readers read more books overall compared to print-readers. Furthermore, interviews by Kosch et al. (2021) showed that avid readers are likely to buy a dedicated e-ink e-reader once they run out of storage for their print books. Considering that such extensive reading is most likely when an individual genuinely enjoys the reading activity, it is likely that owners of dedicated e-ink e-readers have autonomous contextual motivation to read for pleasure.

Dedicated e-readers and general-purpose devices provide different affordances and e-reading platforms, and thus, it is plausible to expect that reading behaviour on them cannot be equated. As mentioned earlier, general-purpose devices pose more frequent interruptions, whereas task-switching on an e-ink device is likely to be less common. As the e-ink screen causes less visual fatigue, the reader can continue reading on the device for longer compared to smartphones or tablets with an LCD screen (D’Ambra et al., 2019; Zambarbieri & Carniglia, 2012). Furthermore, a dedicated e-ink e-reader may support frequent reading engagement: as the device is designed for reading, it can work as a reminder to read more often. Additionally, the reader does not need to inhibit the influence of competing applications to continue reading a book on a dedicated e-reader device, and so they may find it easier to begin a reading session compared to general-purpose devices (Kosch et al., 2021). Opening an e-reader device allows the reader to continue from where they left off, which can make these devices attractive for reading frequently for short periods of time outside of the home.

To understand adults' electronic reading behaviour, it is important to study how dedicated e-ink e-readers are used in addition to general-purpose devices. The limited affordances of dedicated e-readers have made it difficult, however, to track reading behaviour. Due to limited web browsing functionality, the e-reader system used in Chapters 4 and 5 could not be accessed on these devices. Instead, in this chapter we make use of user data that were collected by Amazon Kindle, the most popular e-ink e-reader brand in the UK (Kunst, 2017). As described in Chapter 3, the user data collected by Amazon include a variety of information across all Amazon's services. Among these is an anonymous dataset on the user's reading sessions on Amazon Kindle devices and applications, making it possible for us to study reading frequency and task-switching frequency on these devices. Findings from our pilot study (described in Chapter 3) showed that the data included information on Amazon Kindle reading sessions across 5 years of reading a variety of texts on multiple different devices and applications.

User data collected by large corporations such as Amazon differs from data collected for research purposes. Whereas we aimed to capture participants' reading engagement on the e-reader system accurately and in as much detail as possible, user data are generally collected to capture device and application usage, what type of issues users encounter, and to inform advertising (Kunst, 2017; Zhu et al., 2023). Amazon Kindle devices and applications allow users to customise their reading layout on a variety of different devices, however, our pilot showed that this information is not tracked in detail and tracking quality is not constant across the different reading platforms. As a result, user data are more noisy compared to data collected for research purposes.

User data (or 'log-analytics') have been used successfully in previous research to capture variation in reading behaviour. For example, Braslavski, Petras, et al. (2016) analysed user data from an online book-reading service called 'bookmate' to analyse reading behaviour over 10 months from 8,337 users who had paid for a premium membership on the system. Their findings illustrated how reading behaviour can vary in adults' everyday life, from reading frequency to reading speed. However, the sparse nature of the log-analytics data also caused challenges: in a follow-up study focusing on reading behaviour during reading of *War and Peace* by Leo Tolstoy, Tukh et al. (2019) report removing 64% of all reading sessions in the tracking data due to noise. Furthermore, no information beyond demographics was available, and so it was not possible to assess how participants felt about the books they were reading or what their main purpose for reading them was.

Despite the limitations, user data afford us the unique opportunity to observe reading behaviour outside of an experimental setting. User data are often collected without the user's explicit knowledge, although they consent to it when they agree to terms and conditions (Ashford, 2019; Turner, 2019; US Government Accountability Office, 2022). Based on the reaction of Amazon tracking data becoming available to request in 2020 (Paul, 2020), the majority of users were not aware of the extent to which tracking data were collected. As described in the discussion section of Chapter 5, observation can change individuals' behaviour (e.g. Risko & Kingstone, 2011). Using Amazon Kindle user data thus allows us to assess electronic reading behaviour in a natural setting.

Due to the sparse nature of the data, only reading frequency and task-switching could be measured. We expected these measures to be connected to reader characteristics (see Table 6.1 for an overview of our hypotheses): participants with more autonomous contextual and situational motivation were expected to read more frequently (H1.1b and H1.2b), and task-switch less often (H1.1c and H1.2c). Furthermore, we expected task-relevant electronic reading experience (TR-EEXP) to encourage frequent reading engagement and make the reader less vulnerable to interruptions (H1.3b and H1.3c).

Additionally, we studied the connection between reading frequency, task-switching frequency and task-context. In accordance with previous research, we expected dedicated e-ink e-readers to support reading engagement and so result in less frequent task-switching compared to general-purpose devices (H1). Furthermore, dedicated e-ink e-readers may act as a reminded to read and they can make it easy to continue reading a book, even in short pockets of time (D'Ambra et al., 2019; Kosch et al., 2021). Accordingly, we hypothesised that e-ink e-readers would be connected to more frequent engagement compared to general-purpose devices (H2). In addition to these study-specific hypotheses on task-contexts of reading, we inspected whether reading sessions and previous events are connected to reading behaviour. We expected participants to task-switch more often in early reading sessions before they get accustomed to the author's writing style and the story setting (H2.2a, see Table 6.1). No hypotheses were set on the connection between $Event_k$ (the outcome variable) and previous events, $Event_{k-1}$ and $Event_{k-1}$, due to the exploratory nature of this analysis.

Table 6.1

Summary of Hypotheses Addressed in Chapter 6

RQ1: Reader characteristics

	Higher reading persistence	Higher reading frequency	Lower task-switching frequency	Baseline-level and slower reading speed when situational competence is low	More frequent nonlinear navigation when situational competence is low
Situational autonomous motivation is connected to...	H1.1a	H1.1b	H1.1c	H1.1d	H1.1e
Contextual autonomous motivation is connected to...	H1.2a	H1.2b	H1.2c	H1.2d	H1.2e
Task-relevant electronic reading experience is connected to...	H1.3a	H1.3b	H1.3c	H1.3d	H1.3e

RQ2: Task-contexts

	Higher reading frequency	Lower task-switching frequency	Baseline-level and slower reading speed	More frequent nonlinear navigation
Reading location outside of the home is connected to...	H2.1a	H2.1b	H2.1c	H2.1d
Early reading sessions are connected to...		H2.2a	H2.2b	H2.2c
Early locations in text are connected to....		H2.3a	H2.3b	H2.3c
The beginning of reading sessions is connected to...		H2.4a	H2.4b	H2.4c

Note. The highlighted cells indicate which hypotheses could be addressed in the study reported in this chapter.

6.1 Method

6.1.1 Participants

Participants were recruited by social media, email adverts, and word of mouth. Anyone over the age of 18 was eligible to participate if they had used any Amazon Kindle devices or applications in the past on an account linked to Amazon UK. Only participants from the UK were eligible as our pilot assessment of the data showed that user data varied between different Amazon regions. Participants were asked to donate a dataset of their Amazon Kindle UK user data for research and respond to three questionnaires. Participants were compensated with 5GBP for their time, and informed consent was obtained from all participants. The study design was approved by the School of Informatics, University of Edinburgh, ethics committee (ref: 2019/81073).

In total, 71 participants registered to take part in the study, and 51 of them responded to the questionnaires and donated their user data (see Figure 6.1). However, only 31 participants were included in the analyses. Twenty participants were excluded from the study (see Figure 6.1). Thirteen of the participants were excluded due to suspected participant fraud as their user data donations closely resembled the donation of another participant who had signed up for the study at the same time. Furthermore, some of the data donations were received soon after the consent was confirmed (< 2 days), which was concerning as the pilot study indicated that Amazon UK user data took 5-10 days to received once it had been requested. To address these issues, we set out criteria to identify any participants who were not eligible to take part, or who were trying to participate multiple times:

1. Any participant that donated a clearly edited or altered dataset was excluded from the study.
2. Any participant that fit the following two criteria was excluded from the study:
    a. Registration and/or data donation were completed within minutes from another participant, and
    b. the donated dataset was distinctly similar to that of the other participant.
3. Any participant that failed any two of the following was excluded from the study:
    a. Failure to correctly respond to one or both of the attention checks embedded in questionnaires

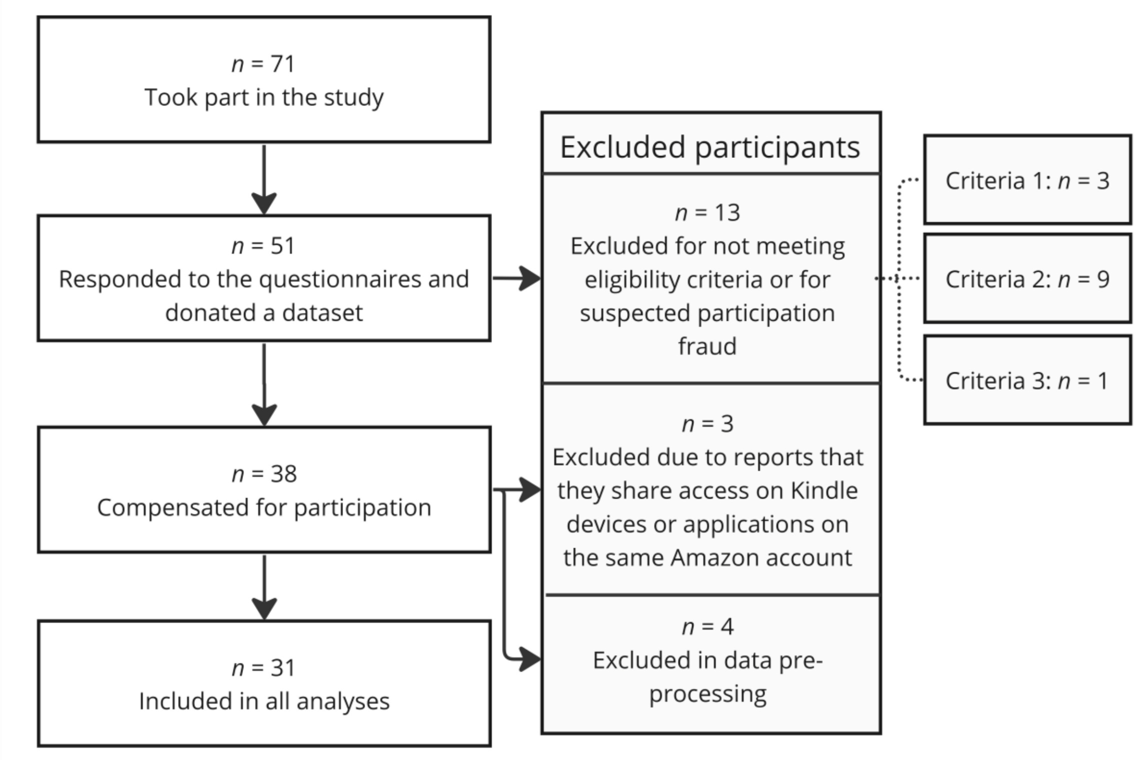
b. Study compensation request was received from outside the UK

c. The participant's data donation was received less than 2 days after the consent was confirmed.

The criteria resulted in the removal of 13 participants, who were then contacted by email and asked to get in touch if the decision was incorrect. Furthermore, three participants indicated that they share access to Amazon Kindle devices or applications on the same Amazon UK account with friends or family. As it was not possible to differentiate between different readers in the user data, these participants were excluded from the study. Finally, four participants were removed in data preprocessing, see 'Data Processing' for more detail.

Figure 6.1

Participant Counts and Exclusions.



6.1.2 Materials: The Questionnaires

Three questionnaires were used to measure participant demographics, their contextual and situational reading motivation, and TR-EEXP. Participants first responded to the Intrinsic Motivation Inventory on Reading (IMI-R), as described in Chapter 3. Similarly to Chapters 4 and 5, contextual reading motivation was measured by summing participants' responses to the IMI-R subscale of contextual reading interest, whereas participants' self-reported reading ability was measured by the subscale of contextual reading competence. The full-scale and the subcomponents had good internal consistency (α = .93-.96).

The questionnaire to measure TR-EEXP, on the other hand, was modified to ensure that we could capture participants' experience of using devices that were included in their Amazon Kindle user data. Participants were asked to report which Amazon Kindle devices and application they had used for reading, and whether they shared access to these devices with family or friends under the same Amazon UK account. Seven items relating to participants' frequency of reading different text types as part of work or study were removed to reduce the time it took participants to respond to the questionnaires. See Appendix A for all questionnaires and changes done for the current study.

TR-EEXP was studied by two measures: frequency of using task-relevant digital devices for recreational reading and frequency of reading task-relevant text types electronically. For the latter, we summed participants' responses on items measuring their frequency of reading long-form narrative texts ('How often do you read fiction books/short stories electronically?'). Digital device experience, on the other hand, was calculated based on the Amazon Kindle devices and applications that participants reported using: we summed together participants' frequency of using smartphones, tablets, laptops, dedicated e-ink e-readers, and desktop computers for recreational reading depending on which of these devices were used by each participant.

Participants' situational reading motivation was measured by a new 'book questionnaire'. Once the participants had donated their user data, it was automatically parsed to find the books that participants spent the most time reading. The system then crawled the Amazon UK website for the cover, title and author of each identified book. In the questionnaire, participants were presented with the cover, title and author of the book they had spent the most time reading, and they were asked to indicate whether they remembered reading it. If the participant responded 'yes', they were asked to estimate how far in the book they read (from '0% - none of the book' to '100% - the entire book'), whether they enjoyed reading it (from 'Not at all' to 'Very much'), and what was their primary reason for reading the book (see Appendix A for the questionnaire). If instead the participant reported that they did not remember reading the presented book, they were shown the following title. Participants were presented a maximum of 30 different titles, and the questionnaire ended once full responses were recorded for 20 texts. Only material that could be automatically found on the Amazon UK website could be included in the book questionnaire. Participants responses to the second question (*'Did you enjoy reading the above book?'*) were used as a measure of situational motivation. More autonomously motivated participants were expected to report higher enjoyment of the text.

6.1.3 Materials: The e-Reader Study Portal

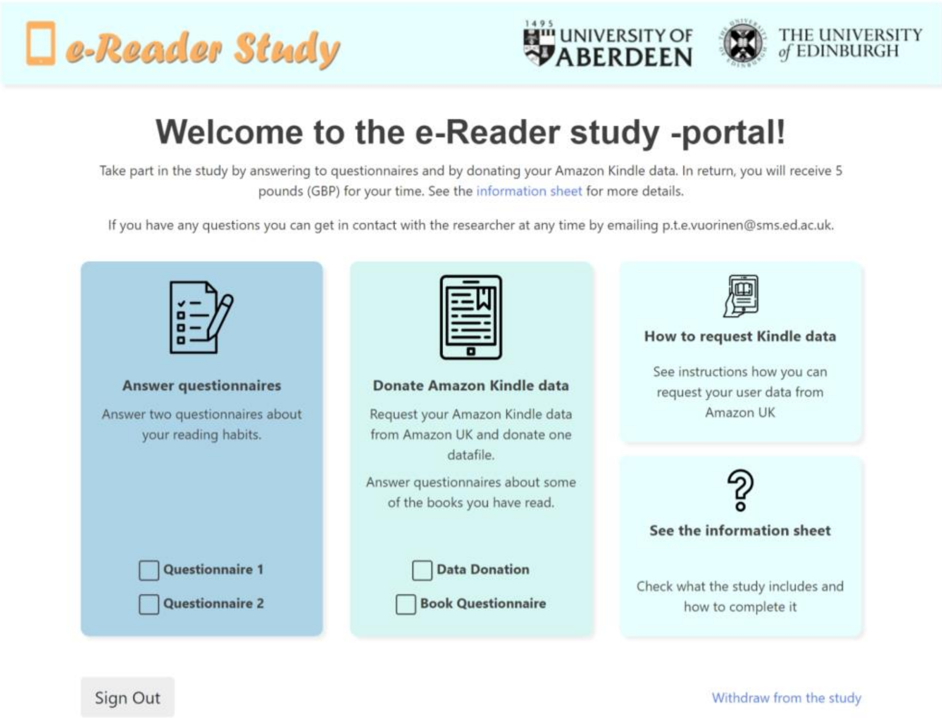
A data donation platform called 'the e-reader study portal' was created in collaboration with a professional web developer. Participants could use the portal to take part in the study, answer questionnaires, and donate their user data (see Figure 6.2). The portal included more information on the study, such as instructions on how to request and donate user data (see Appendix F), and participants could use it to withdraw from the study if they wished.

To donate their user data, participants were first asked to request it from Amazon UK. Participants were given a link and asked to log in to Amazon UK to submit the data request. Participants were informed that they would receive a notification in their email address from Amazon UK once the data request was complete, which could take 5-10 days. Once the participants had received their user data, they were asked to donate an anonymous dataset on their Amazon Kindle reading sessions in the study portal. The data were uploaded on the portal by selecting one file from their computer. Only one file with the correct title ('Kindle.Devices.ReadingSession') was accepted, either as a .csv or a .zip file. Once a file with the correct title and file type was selected, it was automatically parsed to make sure it included the expected column headers. After successfully competing the data donation, the participants were informed that the book questionnaire was available to respond to.

Once all three questionnaires had been completed and the data donation had been received, participants could click on 'finish the study and request compensation' in the portal. Participants were asked to input their email address that was sent to the researcher to complete the monetary compensation request.

Figure 6.2

Screenshot of the e-Reader Study Portal.

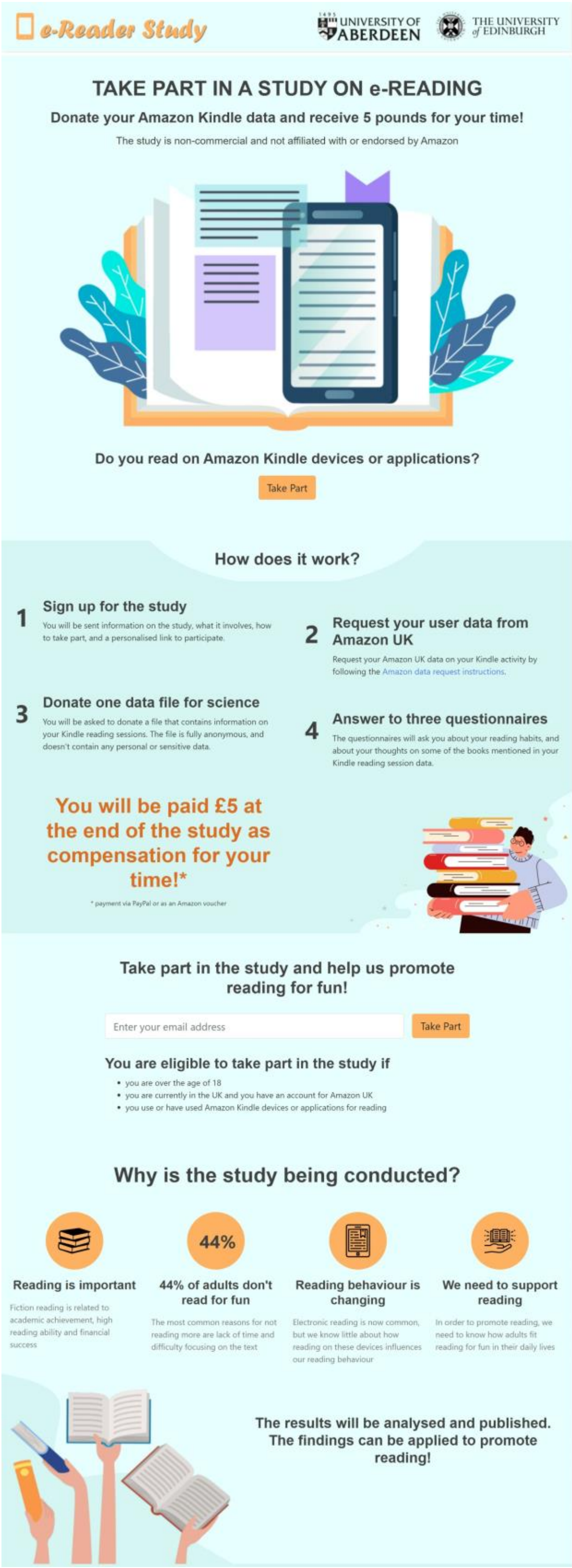


6.1.4 Procedure

Anyone interested in taking part were asked to sign up on the study website (see Figure 6.3, see preview version at https://e-readerstudy.vuorinen.info/). After signing up with their email address, participants were sent more information on the study. They were told that the study includes three questionnaires and donating an anonymous dataset from their Amazon Kindle user data. Additionally, the email included a personalised link to the e-reader study portal. The link was tied to the participant's encrypted email address, and they were asked to not share it with others.

Figure 6.3

Screenshot of the Study Website



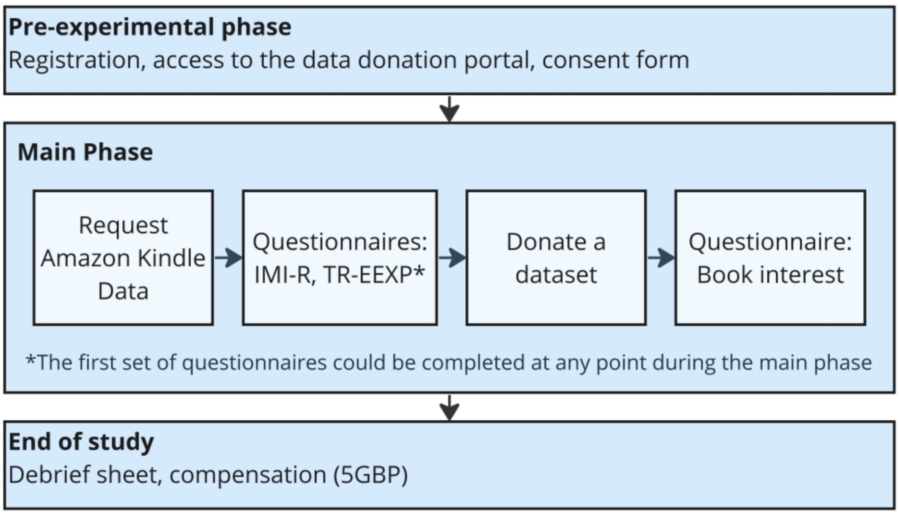
Clicking on the link took participants to the e-reader study portal (see Figure 6.2) on which they first completed the consent form (see Appendix B). Participants could then use the portal freely, to respond to questionnaires, donate their Amazon Kindle data, or view more information on the study. The first two questionnaires could be completed at any point during the study, whereas the third (book questionnaire) only became available once the participants had donated their Amazon Kindle user data (see Figure 6.4).

Once the participants had responded to the questionnaires and donated their dataset, they could select to finish the study in the e-Reader study portal. Participants were asked to input their email address to have the researcher contact them about compensation. Finally, participants were presented with a debrief sheet with more information on the study and thanked for participating.

Participants were sent automatic reminder emails during the study. The emails were sent once a week for all participants. The messages were also used to inform participants about the study ending a few weeks before the recruitment phase was finished.

Figure 6.4

Procedure of the Study



6.1.5 Data Processing

The raw datasets included 54,225 events from 35 participants. Our pilot study (see more detail in Chapter 3) indicated that each event in the dataset represents a continuous engagement with a text from the moment a book is opened, to closing of the device or application. If a dedicated e-ink e-reader was left undisturbed, the screen timed out after 10 minutes of inactivity, whereas in Amazon Kindle applications the inactivation varied depending on the user's device settings. Each continuous engagement had information on the start time, total duration of the engagement block, how many pages were turned during this time, which book was read, and which device was being used.

Information about participants' books and devices were added to the datasets by comparing them to information in the web. Device indicators were listed as serial numbers for Amazon Kindle e-ink e-readers and Amazon Fire devices, whereas Amazon Kindle applications were identified by random device indicators. A list of Amazon Kindle and Fire device serial numbers was used to identify Amazon devices in the donated datasets. Similarly, information on books read was included in the datasets as a searchable content indicator if the book had been purchased from Amazon, and as an encrypted indicator if the book had been otherwise loaded on the device.

The datasets were pre-processed before they could be used in analyses. First, any events that were missing key information were removed. The timing and duration of continuous engagements were needed for both reading frequency and task-switching frequency measures, and thus, any events that were missing this information were removed. In total, 8,776 events with incomplete information were identified from 32 participants. Two participants in the study only had events with limited information, and so they were excluded from the study.

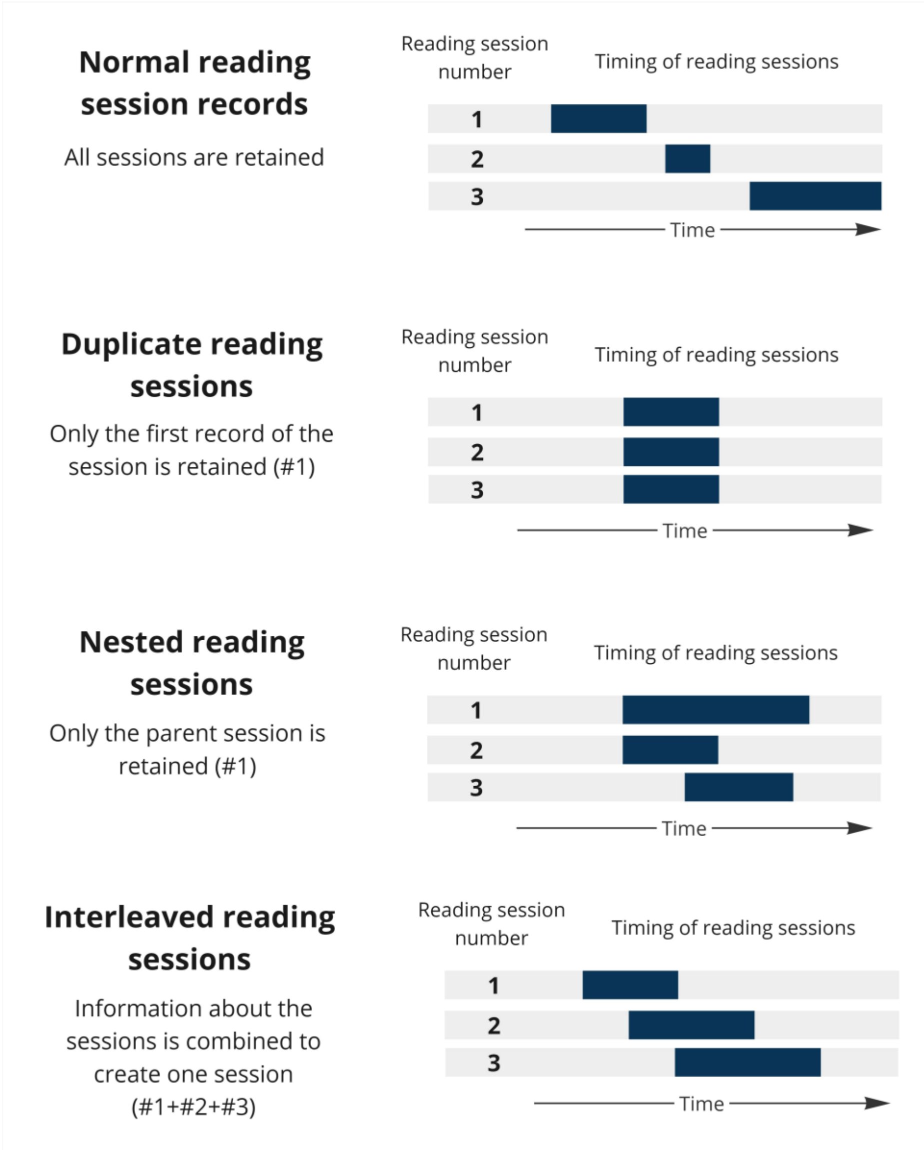
Second, we calculated a reading session for each event. Similarly to studies presented in Chapters 4 and 5, reading sessions began when the user opened a book and ended after 60 minutes of inactivity. Participants could change their reading device within a reading session if they continued reading the same book on a new device within an hour of their previous engagement. In contrast, opening a different book started a new reading session.

To match the Amazon Kindle user data events with our reading session definition, we measured time in between recorded engagements and combined events that occurred within 60 minutes of each other in the same reading session. During this assignment, however, some of the events were found to be overlapping. Consecutive overlapping events were recorded on the same device, during reading of the same book. Therefore, we assumed that these events were artefacts due to errors in the data collection. 528 events were found to be mistakenly reported, of which 29 were duplicates, 385 of the events were nested within each other, and

114 of the events were interleaved with each other (see Figure 6.5). The first two could be removed from the data, whereas interleaved events were combined into a single reading session by using the start time of the first reading event and the end time of the last.

Figure 6.5

Errors in Reading Session Records and How They Were Addressed.



Similarly to our previous studies, any reading sessions that lasted for less than a minute were removed. This resulted in removal of 5,295 sessions from 32 participants. All reading sessions were removed from two participants, and thus they were excluded from the study. In addition, any reading sessions that were longer than three standard deviations away from the mean were identified as potential artefacts. In our previous studies, this was not a necessary step as the e-reader system could accurately capture the duration of reading sessions from the continuous record of participants' reading engagement. However, the user data used in the current study may have been vulnerable for errors. Indeed, inspection of the data showed that the longest reading session lasted for 119 hours, which was unlikely to reflect the participant's real reading session duration. In total, 60 reading sessions from 8 participants were found to be three standard deviations beyond the study average (>5.5h), and thus they were removed from the analysis.

Our focus was on studying behaviour during reading of narrative long-form fiction, and thus we aimed to identify the genre and type of reading materials. We crawled the Amazon UK website and associated API on other web pages to gather information about the title, author, and genres of each book mentioned in the datasets. Only information on books sold by Amazon Kindle UK could be identified if they were still available and listed under the same unique content indicator. Of the 3,262 books included in the user data, 29.4% could be identified. Of these texts, 70.9% were categorised as fictional novels read in English. Any materials that were identified as expository, graphic novels, poetry, or written in a different language were removed from the datasets. This resulted in removal of 4,450 events from 25 participants. Texts that could not be identified as fiction were not removed from the analyses, however, their effect on reading behaviour was inspected in the multilevel models. In total, we analysed reading behaviour across 14,322 events recorded during reading of books that could be identified as fiction, and 19,109 events during reading of texts of which genre could not be confirmed.

6.1.6 Data Analysis Approach

Reading frequency and task-switching frequency were modelled by reader characteristics and task-contexts to address our hypotheses. Two versions of the reader characteristics model presented in Chapter 3 were used, the first of which included all observations, whereas the second was focused on the books that participants provided more information in the book questionnaire. Hypotheses on the connection between reading behaviour, contextual motivation, and TR-EEXP could be addressed by studying either of the models, but hypotheses on situational motivation could only be studied with the latter.

Task-contexts models, on the other hand, included predictors on the timing of reading sessions, reading behaviour at previous events, and information on the device being used. The last was measured by a binary indicator of whether the device was a dedicated e-ink e-reader or a general-purpose device, such as a smartphone, Amazon Kindle Fire tablet, or a PC.

Both the task-context models and the first reader characteristics model included a control variable indicating of whether a book could be confirmed to be fiction or not. If the control variable was a significant predictor in the model, we further investigated whether a model focusing only on identified fiction would lead to different results. In addition to the random effects of subject indicator and book indicator, the models included a random effect of device indicator to account for random variation between different Amazon Kindle applications and devices.

6.1.7 Design

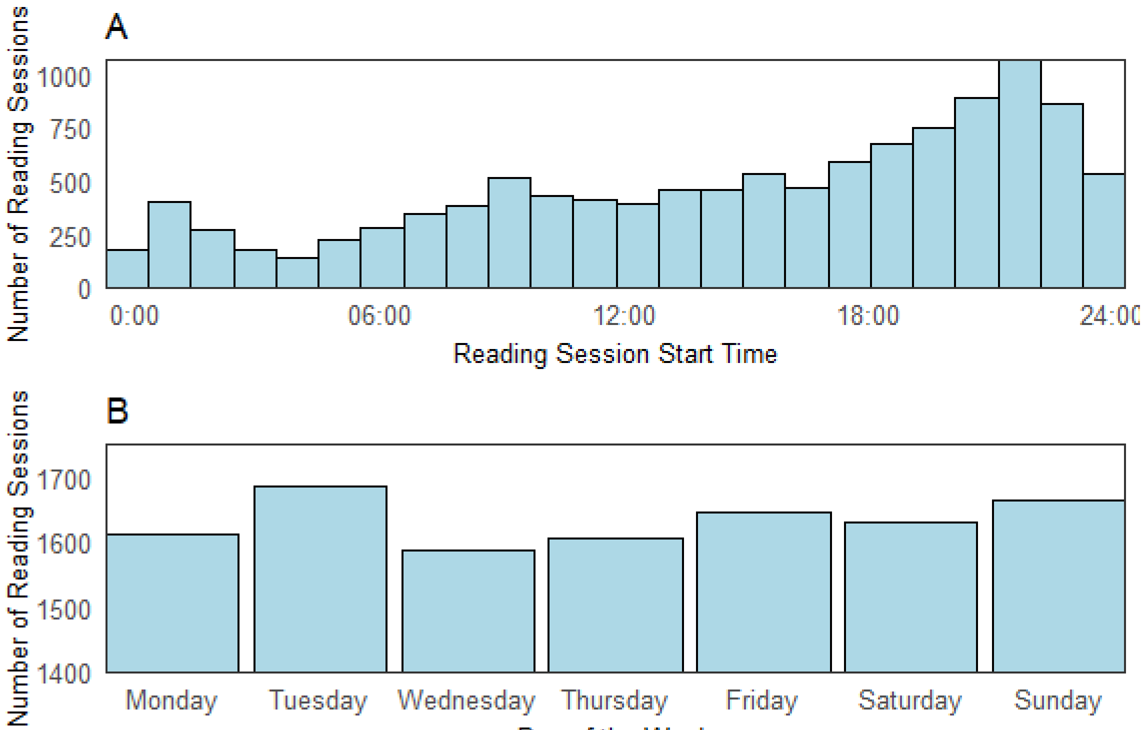
The current study had a between-subjects design. Our dependent variables were the two measures of reading behaviour: reading frequency and frequency of task-switching. Independent variables, on the other hand, included contextual and situational motivation, and TR-EEXP for the reader characteristics models, and reading session number, device type, and reading behaviour at previous events for the task-contexts models.

6.2 Results

On average, participants had 368.8 reading sessions (*SD* = 1.7) across 2.7 years (*SD* = 2.4, *range* = 1.2 minutes - 11.2 years). The average reading session lasted for 31.5 minutes (*SD* = 21.6). Reading sessions occurred most often in the evenings, whereas no clear patterns were visible between different days of the week (see Figure 6.6). In total, participants had spent, on average, 291.5 hours using Amazon Kindle devices and applications (*SD* = 686.9 hours, *range* = 1.2minutes – 3,729.1 hours).

Figure 6.6

Reading Session Timings Across A) Times of the Day and B) Days of the Week.



Participants were recorded reading 1 to 1,106 different books (*M* = 100.6, *SD* = 231.3). On average, participants spent 2.9 hours reading each book (*SD* = 6.8), however, some of the books were read for up to 296.8 hours in total. Only a few titles occurred on multiple participants' reading events: Pachinko by Min Jin Lee and Red, White & Royal Blue by Casey McQuiston were read by four participants whereas Hamnet by Maggie O'Farrell was read by three different participants.

The majority of participants (74.2%) alternated between different reading materials. On average, 9.3% of reading sessions included participants switching to a book that they had read previously (*SD* = 11.5%). Similarly, in the questionnaires, the majority of participants indicated that they read multiple books at once (58.1%), and they may start a new book while they are in the middle of an old one (64.5%). Interestingly, however, the self-report responses and proportion of book alternating on Amazon Kindle devices and applications were not significantly correlated, r = .197- .244, p = .185- .287.

On average, participants used 2.6 different Amazon devices and applications (*SD* = 1.7). Approximately half of the participants used a dedicated e-ink e-reader (54.8%), whereas the remaining 45.2% relied on general-purpose devices. The participants who used e-ink devices read on other devices infrequently (*M* = 23.2% of reading sessions, *SD* = 34.4%). Overall, the majority of reading sessions occurred on dedicated e-ink e-readers (73.2%), and indeed, the participants who used e-ink e-readers had a significantly higher number of reading sessions overall, $t(17) = -2.708$, $p = .015$.

6.2.1 Reading Motivation

As expected, participants were highly contextually motivated to read for pleasure (see Table 6.2). On average, participants reported reading ‘a few times a week’ for pleasure (*M* = 3.8 *SD* = .9), and work or study (*M* = 4.2, *SD* = 1). On average, participants reported that they had read 16-25 books for pleasure last year (*M* = 4.9, *SD* = 1.6). Recreational reading frequency and books read in the past year were significantly, positively connected to contextual motivation, $r = .400\text{-}.536$, $p = .026\text{-}.002$, whereas reading for work or study was not connected to contextual motivation, $r = .244$, $p = .187$.

Participants’ responses to the book questionnaire showed that, on average, they enjoyed the books they spent the most time reading (see Table 6.2). Most of the books were read to completion (83.4%). Indeed, self-reported persistence was significantly positive associated with situational motivation, $r = .300$, $p < .001$, indicating that participants were more likely to finish books that they enjoyed. The majority of books were read because of interest in the premise (82.8%), whereas 11.1% of the books were read because the participant expected to learn something, and 2.9% were read for a book club.

6.2.2 Electronic Reading Experience

Participants reported owning, on average, 3.4 different devices (most often a smartphone, laptop, and dedicated e-ink e-reader, *SD* = 1.1). The majority of participants indicated that they read Amazon Kindle e-books on a smartphone (74.2%) or a dedicated e-ink e-reader (71%). In contrast, only a few participants reported using Amazon Kindle for PC (29%), Kindle Cloud web reader (19%), or a Kindle Fire device (13%). Most of the participants accessed their e-books on 2-5 different devices (61.3%) whereas the remaining 38.7% only used one device.

Participants reported e-reading novels most often (*M* = 3.4, *SD* = 1). Academic journals (*M* = 3.2, *SD* = 1.3), nonfiction books (*M* = 2.6, *SD* = 0.9), magazine and newspaper articles (*M* = 3.0, *SD* = 1.5), and textbooks (*M* = 3.0, *SD* = 1.2) were read, on average, a few times a month, whereas short stories and graphic novels were read a less often (M_{stories} = 2.4, SD_{stories} = 1.3, $M_{\text{graphic novels}}$ = 1.8, $SD_{\text{graphic novels}}$ = 1.1).

TR-EEXP was measured by participants' frequency of reading task-relevant text types (novels and short stories) and usage of task-relevant digital devices for recreational reading purposes (smartphones, tablets, PCs, laptops, and dedicated e-ink e-readers depending on which devices participants reported that they use to access Amazon Kindle). Participants used task-relevant devices and read task-relevant text types electronically, on average, 'a few times a month' (see Table 6.2). Similarly, print books were read on average 'a few times a month' (*M* = 3, *SD* = 1.1). Indeed, most of the participants indicated that they alternate between reading of electronic and print books (54.8%).

Table 6.2

Descriptive Results

		Mean (SD)
Situational motivation		
	Book enjoyment	4.04 (1.07)
Contextual motivation		
	Interest	5.95 (.85)
	Competence	5.38 (1.33)
Electronic reading experience		
	Task-relevant text types	2.89 (.87)
	Task-relevant digital devices	1.98 (1.27)
Reading behaviour		
	Frequency: Time between reading sessions (days)	11.30 (66.53)
	Task-switching: Continuous engagement duration (min)	15.70 (27.12)

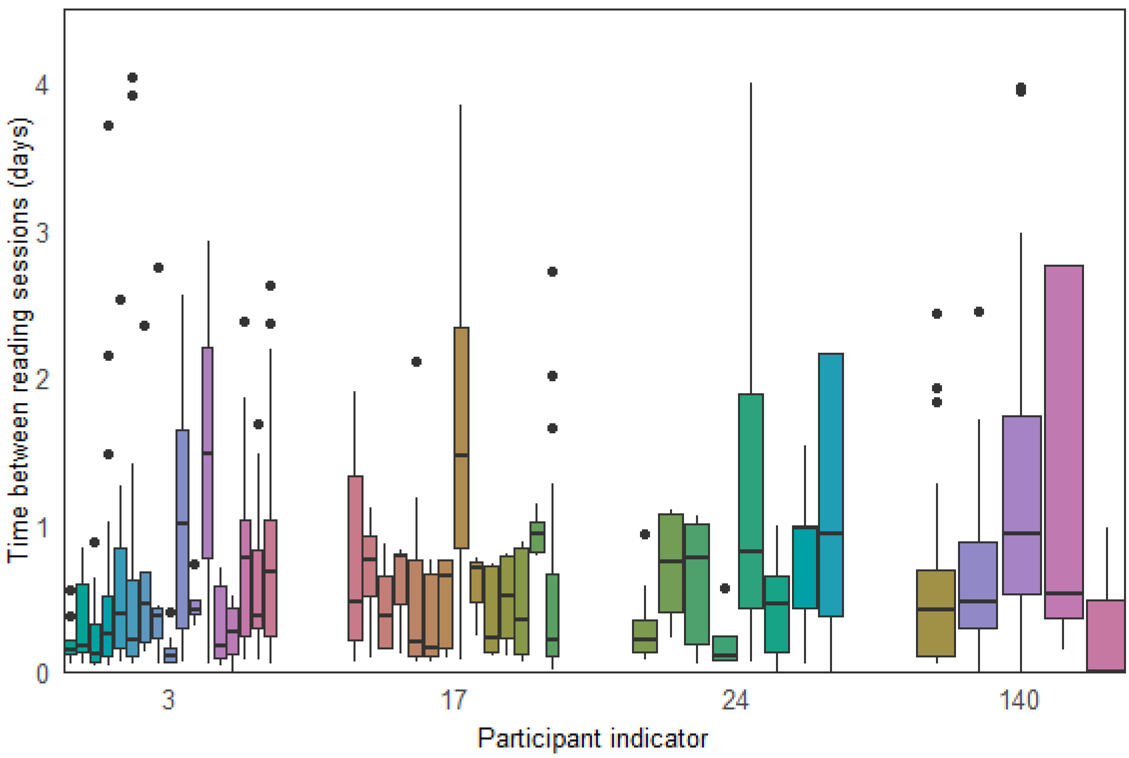
6.2.3 Reading Behaviour

6.2.3.1 Reading Frequency

On average, participants read on Amazon Kindle devices or applications every 2.7 days (*SD* = 28.4). Reading frequency was measured in relation to each book (see Figure 3.6 in Chapter 3), and the time in between consecutive sessions reading the same book was lower than the overall average (see Table 6.2), due to alternation between different books. Reading frequency varied considerably between participants, but also within-participants across the different books read (see Figure 6.7).

Figure 6.7

Four Participants' Variance in Reading Frequency.



Note. The coloured boxplots show different books. Only the maximum of 20 books that participants spent the most time reading are shown.

Reading frequency was modelled by reader characteristics to assess whether reading motivation and TR-EEXP were connected to how often participants returned to a book. Participants' reading frequency did not significantly differ for books that we could and could not confirm as fiction, and the two reader characteristics models (full observations and book questionnaire responded books only) did not result in different results for contextual motivation or TR-EEXP. As a result, we only present results from the second reader characteristics model in this section, see findings on the alternative models in Appendix D.

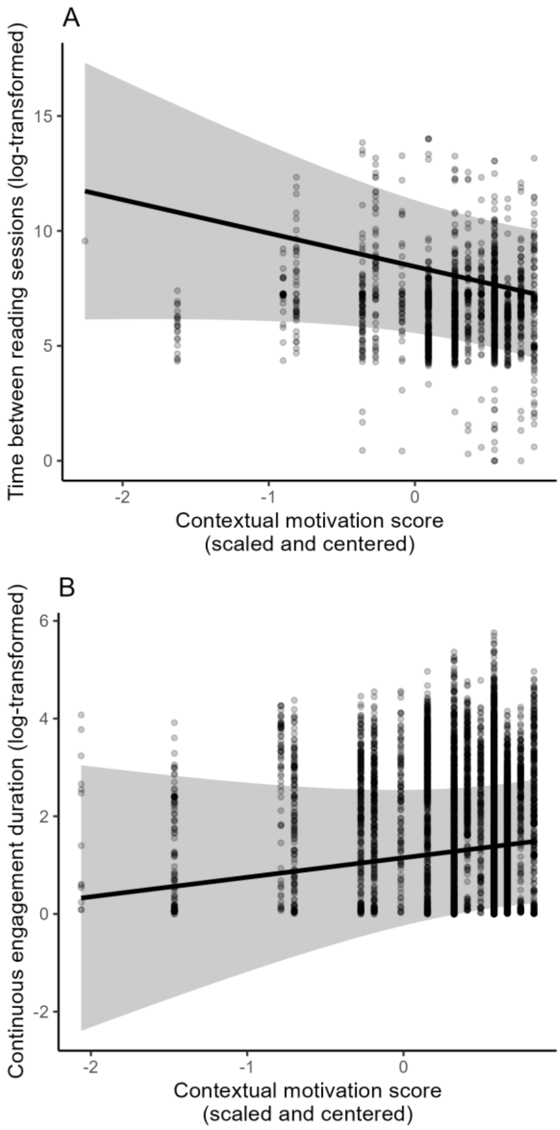
We expected contextual and situational reading motivation to be connected to participants' reading frequency (H1.2b and H1.1b). The former hypothesis was not supported as contextual motivation was not connected to reading frequency (see Table 6.3). Although non-significant, the main effect was in the direction we expected, suggesting that we may have lacked power to detect an effect (see Figure 6.8 A). In contrast, situational motivation was significantly connected to reading frequency, supporting our hypothesis H1.1b. The finding showed that participants who reported enjoying a book more, also returned to it more often (see Table 6.3).

Similarly to motivation, we expected TR-EEXP to contribute to readers' engagement with a book and thus we hypothesised that reading frequency should be associated with TR-EEXP (H1.3b). However, the hypothesis was not supported as the interaction between the two TR-EEXP measures was not a significant predictor of reading frequency.

Task-contexts model was used to assess whether reading frequency was connected to the devices used or timing of reading sessions. Predictors on behaviour at $Event_{k-1}$ and $Event_{k-2}$ could not be included in the model as they would have resulted in considerable data loss due to missing values (up to 29.5%). The task-contexts model was only conducted once as the binary indicator on whether a book could be identified as fiction or not was not a significant predictor of reading frequency, suggesting that repeating the model with only identified fiction would have been unnecessary (see Table 6.4). The results showed that device type was not associated with reading frequency, contrary to our hypothesis H1 (see Table 6.4). This suggests that participants reading a text on dedicated e-ink e-readers did not return to the book more frequently compared to those who were using general-purpose devices, such as a smartphone or a laptop.

Figure 6.8

Trend Between Contextual Reading Motivation and A) Reading Frequency and B) Task-switching Frequency



Note. Reading frequency was measured by time between reading sessions, whereas task-switching frequency is indicated by continuous engagement duration. The points show observations, the lines indicate of the model fit and the shaded areas show 95% confidence interval.

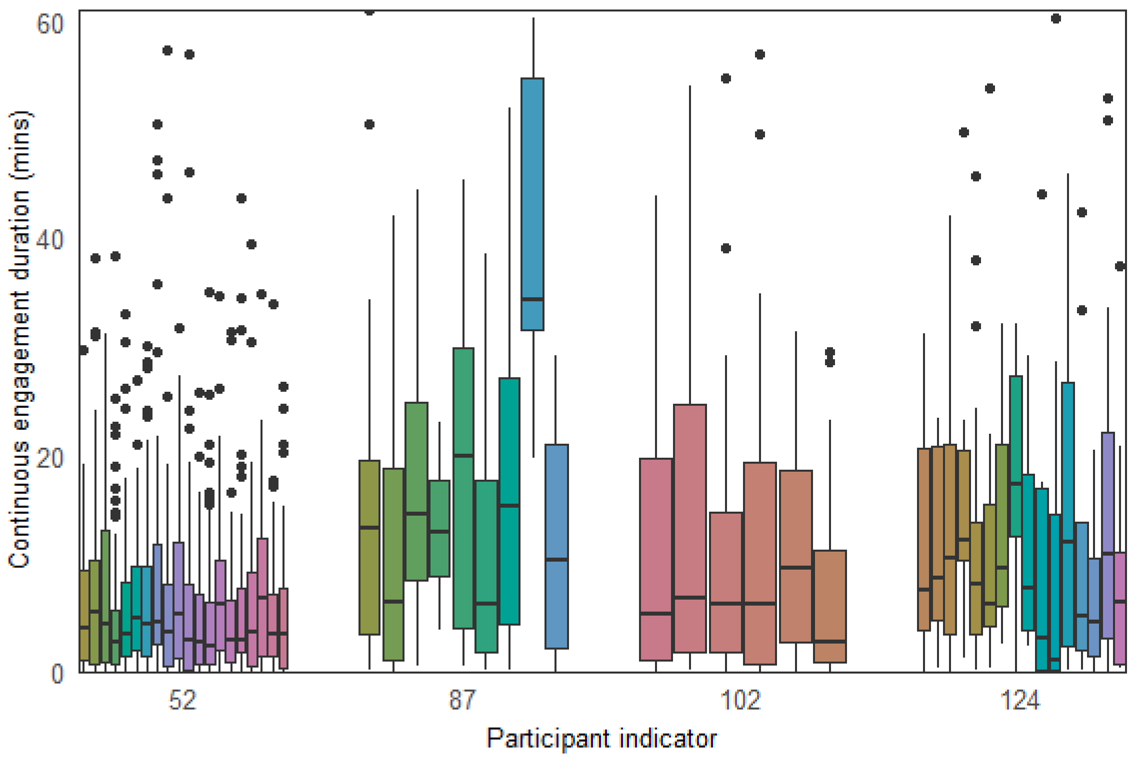
6.2.3.2 Task-switching Frequency

Participants had, on average, 1,222 continuous engagements recorded in their user data (*SD* = 1,632.7, *range* = 4-6,668), and 10.7 continuous engagements for each book (*SD* =

38.8). The duration of these continuous engagements was used as a measure of task-switching frequency (see Figure 3.6 in Chapter 3), similarly to Chapters 4 and 5. On average, a continuous engagement lasted for 15.7 minutes (*SD* = 27.1), although this value varied considerably between different books read (see Figure 6.9 and Table 6.2).

Figure 6.9

Four Participants' Variance in Task-switching Frequency.



Note. The individual boxplots show variance in task-switching frequency during reading of different books.

Similarly to reading frequency, task-switching was modelled by reader characteristics using both a full-observations model and a model focused on the books that they provided additional information on. In the first model, a binary indicator of whether we were able to confirm each book to be fiction or not was significant, indicating that participants task-switched more often during reading of books confirmed to be fiction (see Appendix D for more information). Furthermore, participants' continuous engagement durations were longer if they were reading one of the books that they responded to in the book questionnaire (see Appendix D). This indicates that participants task-switched less often when reading one of the books that they spent the most time on. Despite these differences, the alternative reader characteristics models' results did not vary in relation to our hypotheses, and thus only the book questionnaire model is presented in this section.

We expected participants' reading motivation to be connected to less frequent task-switching (H1.1c and H1.2c). However, neither contextual or situational motivation were significant predictors in the model, and so these hypotheses were not supported (see Table 6.3). Although non-significant, contextual motivation showed the expected direction of the effect, similarly to reading frequency (see Figure 6.8 B). In contrast, no relationship was observed between task-switching frequency and situational motivation.

TR-EEXP was expected to support participants' reading engagement, and thus we hypothesised that TR-EEXP should be positively connected to continuous engagement durations, indicating of infrequent task-switching (H1.3c). However, the interaction between the two TR-EEXP was not connected to task-switching frequency (see Table 6.3), and so our hypothesis was not supported.

Instead of motivation or TR-EEXP, the model results showed that gender was a significant predictor of participants' task-switching frequency (see Table 6.3). The finding indicated that women task-switched less often than men. The result was only found in the book questionnaire focused reader characteristics model (see Appendix D for the alternative models), however, indicating that gender was associated with task-switching frequency only during reading of the books that the participants spent the most time on.

Table 6.3

Findings from Reader Characteristics Models

	Reading Frequency		Task-switching	
	b	*SE*	*b*	*SE*
Fixed effect				
Intercept	7.821***	0.604	1.925***	.276
Age	.332	0.354	.231	.156
Gender: M vs F	.502	1.175	1.291*	.589
English as a native language (binary)	-.625	0.684	.531	.339
Education: Tertiary vs Lower	-1.165	1.472	-.805	.658
Book enjoyment	-.118*	0.059	-.008	.034
Contextual interest (CINT)	-1.454	0.891	.400	.450

Contextual competence	.344	1.020	-.691	.524
TR-EEXP1: Task-relevant text types	.342	0.225	-.061	.136
TR-EEXP2: Task-relevant digital devices	.012	0.356	-.342	.171
TR-EEXP1 x TR-EEXP2	-.036	0.207	-.199	.117
Random effect	*Variance*	*SD*	*Variance*	*SD*
Subject indicator	.806	0.898	.052	.228
Book indicator	.375	0.613	.107	.327
CINT (slope)	1.863	1.365		
Device indicator	.536	0.732	.417	.646
CINT (slope)			.316	.562

Note. Continuous variables have been centred around the mean, and categorical predictors were given Helmert contrasts. *b* = coefficient, *SE* = standard error, *SD* = standard deviation,'*': *p* < .05,'***': *p* < .001.

In addition to reader characteristics, task-switching frequency was modelled by task-contexts. Comparison of two alternative models reiterated that books that could not be confirmed to be fiction differed from the identified fiction books. Whereas in the full sample model an interaction effect between reading session number and device type was a significant predictor of task-switching, this was not the case in the identified fiction model (see Table 6.4), and so we present both models.

Dedicated e-ink e-readers were expected to be connected to less frequent task-switching compared to general-purpose devices, such as smartphones or laptops (H2). The findings showed that participants task-switched less often when reading the book on a dedicated e-ink e-reader, supporting our hypothesis (see Table 6.4). Indeed, the average continuous engagement duration on an e-ink e-reader was considerably longer than on a general-purpose device ($M_{\text{e-ink}}$ = 21.8 min, $SD_{\text{e-ink}}$ = 33.4 min, M_{general} = 8.5 min, SD_{general} = 14.9 min).

In addition to device type, task-switching was expected to be more frequent in early reading sessions, in indication of low familiarity with the story and writing style of a book (H2.2a). However, our hypothesis was not supported as reading session number was not a significant predictor of task-switching frequency (see Table 6.4). Instead, an interaction effect between reading session number and device type showed that participants who read the book on a dedicated e-ink e-reader were likely to task-switch less often in later reading sessions, whereas no connection was found between task-switching frequency and reading session number if the book was read on a general-purpose device. However, the interaction was not observed for the identified fiction only model, suggesting that the effect was driven by the unconfirmed titles in the full sample model.

Finally, the results showed that previous events could be used to predict participants' continuous engagement duration: $Event_{k-1}$, $Event_{k-2}$, and an interaction between them were significant predictors in the model (see Table 6.4). The results showed that previous events were positively associated with continuous engagement duration at $Event_k$ (the outcome variable). Variation in task-switching frequency was nevertheless common, as the interaction effect indicated that continuous engagement duration at $Event_k$ was likely to be long if it followed from a similarly long continuous engagement at $Event_{k-1}$ and a short engagement duration at $Event_{k-2}$.

Table 6.4

Findings from Task-contexts Model of Task-switching Frequency

	Reading Frequency		Task-Switching Frequency			
	Model 1		Model 1		Model 2	
	b	*SE*	*b*	*SE*	*b*	*SE*
Fixed effect						
Intercept	7.136***	.143	2.126***	.225	2.066***	.230
Text status (confirmed or not)	.122	.147	-.116***	.033		
Device type (e-ink e-reader or not)	-.041	.221	1.138***	.149	.907***	.225
Event k-1			.069***	.011	.135***	.021
Event k-2			.067***	.010	.080***	.020
Reading Session Number (RSN)	-.022	.150	.205	.397	-.170	.512
Device type x RSN	-.208	.294	.551***	.153	-.127	.376
Event k-1 x Event k-2			-.053***	.006	-.063***	.011
Random effect	*Variance*	*SD*	*Variance*	*SD*	*Variance*	*SD*
Subject indicator	.230	.479	.478	.691	.570	.755
RSN (slope)			2.232	1.494	4.741	2.177
Text status (slope)	.206	.454				
Book indicator	.389	.624	.034	.184	.032	.180
RSN (slope)	.746	.864				
Event k-1 (slope)			.040	.199	.049	.221

Event k-2 (slope)			.025	.157	.034	.186
Device type (slope)	.595	.771	.261	.511	.164	.406
Device indicator	.270	.519	.146	.382	.211	.459
RSN (slope)	.351	.593				

Note. Model 1 represents the full sample model that included both books that were confirmed to be fiction and those of which text type could not be confirmed. Model 2 only included books confirmed to be fiction. Both models are reported for task-switching frequency, however, the two models did not result in significant differences for reading frequency and so only the first model is reported here. Continuous variables have been centred around the mean and categorical predictors were given Helmert contrasts. Event k-1 describes the previous event, and Event k-2 shows the event preceding the previous (compared to Event k which represents the outcome variable). b = coefficient, SE = standard error, SD = standard deviation,'***': $p < .001$.

6.3 Discussion

In this chapter, we studied reading behaviour across multiple different texts by analysing Amazon Kindle user data. The datasets included information on reading behaviour from approximately 2.7 years of reading sessions (up to 11.2 years), and from up to 1106 books read on Amazon Kindle devices and applications. Although the majority of participants spent a great deal of time reading on Amazon devices and applications (M = 291.5 hours, SD = 686.9 hours) the sample also included participants who used Amazon Kindle for only a few minutes in total.

The majority of participants' reading sessions were recorded on dedicated e-ink e-readers that could not be assessed in our previous two studies, presented in Chapters 4 and 5. The datasets were used to measure participants' reading frequency and task-switching tendencies that were then analysed by multilevel models to assess whether behaviour was associated with reader characteristics and task-contexts.

6.3.1 Task-contexts

We expected dedicated e-ink e-readers to encourage frequent reading engagement (H1) and support longer continuous engagements (H2). The findings showed that participants indeed task-switched less often when reading on e-ink e-readers compared to general purpose devices, such as smartphones and laptops. This finding is in line with previous research; for example, interview studies by Kosch et al. (2021) and D'Ambra et al. (2019) indicated that readers find notifications and alerts distracting in general-purpose devices, whereas the limited affordances provided by e-ink e-readers can support extended reading engagement.

Similarly, dedicated reading devices may result in more frequent reading engagement because these devices work as reminders to read more often and they can make it easier to pick up a book without getting sidetracked by competing applications (D'Ambra et al., 2019; Kosch et al., 2021). However, our findings did not support this suggestion as reading frequency was not associated with device type. One potential reason for this is that general-purpose devices and dedicated e-ink e-readers may be used for reading in different contexts: although they may remind the reader to read frequently, the constant availability of a smartphone can make it easy to use for reading in unexpected and brief pockets of time (Kuzmičová et al., 2020). Therefore, smartphones may be used frequently when the individual does not have their dedicated e-reader device with them, whereas reading sessions with e-ink devices may be more intentional. However, this possibility should be assessed further in future studies.

In addition to device type, we expected timing of reading sessions to be connected to reading behaviour (H2.2a). Previous studies have shown that readers are more likely to get immersed further into a text when they have become familiar with the story premise and the author's writing style (Rosenthal, 1995; Syd Field, 2005). During these flow experiences, the reader can focus on a text for extended periods and ignore any distractions (McQuillan & Conde, 1996). Accordingly, we expected that participants would be more likely to task-switch infrequently in later reading sessions. In contrast to our expectations, however, reading session number was not a significant predictor of task-switching frequency.

It is possible that the effect of reading session timing was confounded by participants' enjoyment of the texts that they read. Whereas interesting and enjoyable texts may have been more likely to result in immersion and our expected effect of reading session number, uninteresting books may have been connected to the opposite pattern: readers may feel more distractible during reading of an uninteresting text, whereas enjoyable reading material can keep the reader's attention for longer (Ivey & Johnston, 2013; Van Ammel et al., 2021; Zare et al., 2023). Although we measured participants situational motivation towards the 20 books that they spent the most time in reading, this information was assessed separately from task-contexts in our reader characteristics models.

Due to the high amount of data loss in reading frequency, only task-switching frequency could be studied in relation to previous behaviour. The findings showed that $Event_{k-1}$, $Event_{k-2}$ and an interaction between them could be used to predict participants' continuous engagement durations. Similarly to Chapters 4 and 5, the results showed that participants were likely to use either consistent continuous engagement durations or move between short and longer continuous engagements. This pattern may be reflective of differences between participants in their preference for task-switching or the extent to which they felt vulnerable to distractions.

6.3.2 Reader Characteristics

In addition to task-contexts, we studied the connection between reading behaviour and reader characteristics. We expected reading motivation and task-relevant electronic experience (TR-EEXP) to be connected to reading frequency and task-switching frequency. The findings showed that situational motivation to read a book was positively associated with reading frequency, indicating that participants who were more motivated to read a book returned to it more often. However, no connection was found between situational motivation and task-switching frequency, and so task-switching was not more common during reading of less enjoyable books, contrary to our expectations.

We were only able to assess participants' motivation towards the 20 books that they spent the most time reading, which for some readers was only a small sample of the books they read. It is likely that participants spent the most time reading the books that they were most interested in, and indeed, the average situational motivation score was very high at 4 (on a 5-point scale). An effect of situational motivation for task-switching frequency may have not been noticeable due to this ceiling effect.

Whereas situational motivation was associated with reading frequency, no connection was found between contextual motivation, TR-EEXP, reading frequency, and task-switching frequency. The lack of an effect may have been due to our measurement of contextual motivation and TR-EEXP. Although reading behaviour was recorded across multiple years, contextual motivation and TR-EEXP could only be measured once. It is likely that participants' contextual motivation and TR-EEXP grew across the years that they spent reading on Amazon Kindle devices and applications, or otherwise they would have been likely to stop using these reading platforms (Chau & Hu, 2001; Vernon, 2006). According to Vallerand's (2000) model of hierarchical motivation, contextual motivation can become increasingly autonomous with repeated positive experiences on the situational level. Similarly, task-relevant reading experience increases over time when readers get used to the reading platform and become aware of the affordances it offers (Yoo & Roh, 2019; Zheng &

Li, 2020). As a result, participants' scores in the IMI-R and TR-EEXP questionnaires may have not been representative of the timeline on which reading behaviour was recorded.

6.3.3 Limitations

The current study provides novel information on reading behaviour during reading of multiple different texts on varied devices. We are not aware of other studies that use an ecologically valid, observational approach to studying reading behaviour on dedicated e-ink e-readers and general-purpose devices, and therefore, the findings have considerable potential to inform future research. Despite its contribution, the method has its limitations.

Measures of reading motivation and TR-EEXP may have not been extensive enough to observe connections with reading behaviour. Information on situational motivation was collected for 20 of the books that participants had spent the most time reading. Only 20 books were assessed to avoid overburdening the participants, and the questions were focused on the books that participants spent the most time on to avoid asking them about titles that were accidentally opened or for which reading behaviour data was limited. However, this method resulted in high average situational motivation scores, most likely because uninteresting books were not read to the end and so they were not included in the 20 books in the questionnaire. This possibility is supported by findings from Chapter 5 which indicated that higher situational motivation was connected to higher reading persistence. Similarly, our single measurement of TR-EEXP and contextual motivation may have not been representative of participants' motivation and electronic experience over the years of reading behaviour recorded.

User data can be noisy compared to data collected for research purposes. This issue affected the analysis as 16.2% of data had to be removed due to missing key information, such as timing or duration of continuous engagements. The datasets were pre-processed similarly to data collected with the e-reader system used in Chapters 4 and 5 to remove errors. However, it is likely that the data includes noise that was not captured. For example, the user data included reading sessions that were recorded to last up to 119 hours. This value was assumed to be a mistake, and so the datasets were adjusted by removing any reading sessions that were three standard deviations beyond the mean. Although this method is common in excluding outliers (Smiti, 2020), it does not guarantee that accurately captured reading sessions were retained in the data while errors were removed.

Finally, the reliability of our analyses was limited by a high number of unidentified books. We collected information on book genres from Amazon Kindle and associated API, however, only 29.4% could be correctly identified. The rest of the books listed in the user data had not been acquired from Amazon, or their unique identifier was changed or removed. To avoid data loss, we included both unidentified and identified texts in analyses, however, the former group was likely to consist of highly variable reading materials, including non-fiction which was not our focus in this research project.

6.4 Conclusion

In this chapter, electronic reading behaviour was studied by analysing Amazon Kindle user data. This approach made it possible for us to study reading patterns across multiple different books and a variety of different devices, including dedicated e-ink e-readers. Reading behaviour was captured in the user data from up to 11 years, offering us a unique glimpse into adults' natural electronic reading behaviour. The findings showed that participants with more autonomous situational motivation towards a particular book returned to it more frequently. Furthermore, reading on dedicated e-ink e-readers was connected to less frequent task-switching compared to general-purpose devices. However, other reader characteristics and task-contexts were not associated with reading behaviour, potentially due to the noisy characteristics of the user data. The study contributes to our understanding of reading behaviour, showcasing that behaviour varies both between and within subjects, across the different books read and the variety of devices used.

Chapter 7

Overview of the Thesis

This thesis aimed to enhance our understanding of adults' e-reading behaviour. Previous research has been largely limited to self-reports and lab-based approaches that fail to capture natural reading behaviour accurately. To address this gap in research, we set out to study e-reading behaviour via unobtrusive observation on readers' own digital devices to capture behaviour within an ecologically valid context.

Across three studies, we made use of two novel methodologies. First, we created a web application called the e-reader system to track behaviour during reading. The e-reader allowed us to study behaviour on the page-level using a variety of measures, including reading persistence, frequency, task-switching frequency, reading speed, and linearity of reading. The application was accessed via a web-browser and thus it could be used with a variety of general-purpose devices, such as smartphones and laptops. However, the e-reader system could not be used with dedicated e-ink e-readers with limited web browser functionality. To address this, we assessed reading behaviour by analysing user data from Amazon Kindle devices and applications as part of our second methodology.

In addition to describing adults' e-reading behaviour, we studied how behaviour during reading of long-form fiction is connected to reader characteristics and task-contexts. We set two research questions.

RQ1: Is electronic reading behaviour connected to the readers' characteristics? How?

Previous research has shown that reading motivation is a robust predictor of reading engagement (Bugler et al., 2016; Mol & Bus, 2011; Schiefele et al., 2012). According to Vallerand (2000)'s hierarchical model of motivation and Deci and Ryan (1985)'s Self-determination theory, readers with more autonomous motivation on the situational and contextual levels are more driven to read a particular text and engage in reading as an activity. In turn, a high reading frequency has been connected to various positive life outcomes, such as a high reading skill, educational attainment, and financial independence (OECD, 2016; Teravainen-Goff et al., 2022; Torppa et al., 2020). However, little is known about how motivation influences observable electronic reading behaviour. To address this, we studied the connection between self-reported contextual and situational motivation and reading behaviour.

In addition to reading motivation, we expected participants' electronic reading experience to be connected to their reading patterns. Although electronic reading has become common, few adults are skilled in it (Vernon, 2006). Indeed, the immateriality of electronic texts requires the reader to use different strategies than print (Kuzmičová et al., 2020; Mangen, 2008), which can be learned over time via experience with electronic reading (Yoo & Roh, 2019; Zheng & Li, 2020). We expected that task-relevant electronic reading experience (TR-EEXP) would support reading engagement, and thus result in frequent reading sessions, higher reading persistence, infrequent task-switching, and more adaptable reading patterns.

RQ2: Is electronic reading behaviour connected to the task-context? How?

Reading behaviour is likely to vary in relation to the context in which a book is read. The highly transportable nature of e-books makes them easy to read in a variety of reading locations (Kosch et al., 2021; Kuzmičová et al., 2020). Reading on the go is likely to result in different reading behaviour than reading in the comfort of one's home, especially if the reader needs to keep track of people around them or they face frequent distractions (Kosch et al., 2021; Kuzmičová et al., 2020).

In addition to reading location, location in text and timing of reading session can influence reading behaviour. Different sections of a text place varying demands on the reader; the beginning of the text can feel arduous to read as the reader needs to familiarise themselves with the author's writing style and the story characters (Rosenthal, 1995; Syd Field, 2005). Later sections of the text may feel easier to engage with. Similarly, continuing reading a book is likely to place different demands on the reader compared to starting a book: readers may wish to explore the story structure before committing to reading it (Milne, 2021), whereas in the beginning of following reading sessions, readers may use nonlinear navigation to reread previous sections and remind themselves on where they left off (Iqbal & Horvitz, 2007).

7.1 Summary of Studies

In Chapter 4, we studied 60 undergraduate students' reading behaviour over 14 days during reading of a 15–24-page short story. To influence participants' situational motivation to read the story, we manipulated their sense of autonomy in text selection: half of the participants were given a story that they rated as the least interesting based on its summary, whereas the other half was given the story that they were most interested in reading. Participants' reading behaviour was tracked with the e-reader system, and behaviour was measured by task-switching frequency, reading speed, and linearity of reading.

Chapter 5 built on Chapter 4 with a larger sample size (*n* = 729), a longer observation period (10 months), and full-length texts (89-975 pages). Furthermore, we aimed to measure reading behaviour in a more ecologically valid setting, and so the participants were allowed to select their own reading material. To ensure that the texts were appealing to the participants, we worked with bestselling authors to curate a library of varied, popular novels. Only a natural manipulation was used: participants were asked to read their selected text at least for 70 pages, after which they could finish the study and access an infographic on their own reading behaviour as compensation for taking part. We expected that participants with more autonomous situational motivation would be more likely to continue reading their selected book past this threshold. Reading behaviour was tracked by the e-reader system, similarly to Chapter 4. The large scale of the study allowed us to assess varied reading behaviours, including reading persistence, reading frequency, task-switching frequency, reading speed, and linearity of reading.

Whereas Chapters 4 and 5 focused on reading behaviour during reading of one text on general-purpose devices, Chapter 6 made use of Amazon Kindle user data to assess behaviour across multiple different texts on a variety of devices, including dedicated e-ink e-readers. Furthermore, this method allowed us to study reading behaviour without participants' awareness of being tracked. Previous studies have shown that knowledge of being observed can cause individuals to engage in more socially desirable behaviours (Risko & Kingstone, 2011), biasing observational results. User data are generally collected without the user's awareness, although the user agrees to the observation in terms and conditions (Ashford, 2019; Turner, 2019; US Government Accountability Office, 2022).

In the study, 31 participants requested their Amazon Kindle user data from Amazon UK and donated it for research. The participants responded to questionnaires to assess their reading motivation and TR-EEXP. Although the user data provided a unique opportunity to study behaviour in adults' natural environment across multiple different texts, the noisy and incomplete nature of the reading behaviour data limited our reading behaviour measures to reading frequency and task-switching frequency.

In the following sections, we discuss results in connection to the two research questions. Based on results from all three studies, we create a preliminary conceptual cognitive model of e-reading that summarises the ways in which the participants' read narrative texts. We then conclude this chapter with directions for future research and a discussion on the limitations of the studies. The implications and contributions of this thesis will be discussed further in Chapter 8.

7.2 How Do Adults Read Electronically?

7.2.1 Engagement in e-Reading

The three studies showed that, on average, participants returned to their e-book every three days. Most of the reading sessions occurred in the evenings (see Figure 5.7 and Figure 6.6). In Chapter 5, participants were most likely to read on Tuesday or Wednesdays, whereas inspection of reading on Amazon Kindle devices and applications showed no clear changes across the weekdays.

Participants self-reported reading 'a few times a week', which was in line with the observed reading frequency. However, participants may have read on other reading platforms in addition to that recorded during the study. Indeed, findings from Chapter 6 showed that alternation between different books was common, and it occurred in 9% of the reading sessions. Self-reports supported this finding, as the majority of participants in Chapter 6 indicated that they prefer alternating between different books. More than half of the participants indicated that they tend to alternate between reading print and electronic books, suggesting that the reading frequency recorded in our studies may only reflect a fraction of the reading that the participants engaged in. This is in agreement with findings from Bounie et al. (2013) and Schwabe et al. (2022) who showed that electronic reading often supplements rather than replaces print reading engagement.

On average, the reading sessions lasted for 32-47 minutes. Few previous studies have recorded average reading session durations, however, the few findings that are available have indicated similar session durations. For example, findings from a diary-study by Foasberg (2014) indicated that adults tend to read novels for approximately 69 minutes at a time, whereas analysis of reading logs by Braslavski, Likhosherstov, et al. (2016) suggested that reading sessions tend to last for half an hour. Furthermore, interview studies have suggested that adults often report reading for short periods at once, due to limited time (Kosch et al., 2021; Nolan-Stinson, 2008). It is possible that adults read flexibly to fit reading for pleasure among their daily responsibilities.

Although these findings replicate those from previous research, short reading sessions are not widely acknowledged. Various reading promotions have challenged adults to incorporate one to two hour reading sessions into their daily routines to increase reading engagement. For example, '#readathon' by BookLeaf Publishing encourages adults in the UK to time themselves reading for an uninterrupted one-hour reading session every day (BookLeaf Publishing, 2022). However, our findings suggests that such extended periods of reading are uncommon, and accordingly, they may be difficult to implement. Instead, encouraging reading flexibly, for short periods of time may be more attainable.

Electronic reading platforms have made books highly transportable, and this feature is one of the main selling points for e-reading (D'Ambra et al., 2019). Reading locations could only be studied in Chapter 5, however, to our surprise, the findings showed that the majority of reading sessions occurred at participants' home (78%). Similarly, interviewees in a study by Kosch et al. (2021) suggested that although transportability is a key feature in e-reading, e-books are frequently read in the home as well.

Our findings on reading locations may have been limited by the COVID-19 pandemic. The study presented in Chapter 5 was conducted between August 2021 and July 2022, which coincided with COVID-19 restrictions that may have limited participants' movement outside of their home. Findings from Boucher et al. (2020) and Salmerón et al. (2020) suggested that the pandemic may influence reading behaviour beyond reading locations. Salmerón et al. (2020) observed an increase in overall reading frequency, whereas findings by Boucher et al. (2020) showed that the pandemic may have resulted in a lower reading persistence rate and preference for rereading books that had been read previously. Furthermore, self-reports in Chapter 5 suggested that the pandemic may have had a significant impact on reading engagement, as 45% of participants indicated that COVID-19 influenced the ways in which they read.

7.2.2 Disengagement from e-Reading

Distractions were common during reading sessions, as across the three studies continuous engagement duration was only recorded to last, on average, 10-16 minutes. Previous studies on distractions during studying have indicated similar or lower continuous engagements. For example, findings by Rosen et al. (2013) indicated that students disengage from their study materials every six minutes. Such short continuous engagements are surprising during fiction reading, however, considering that the activity is more likely to be autonomously motivated, enjoyable, and easier than studying (Levine et al., 2022).

Previous research has suggested that electronic reading is characterised by frequent disengagements that result in fragmented reading sessions (e.g., Liu & Gu, 2020; Liu, 2022). Frequent interruptions and short continuous engagements have been connected to low reading comprehension (Liu & Gu, 2020). However, the majority of these studies have imposed forced distractions during the reading task, and so it is unclear whether voluntary engagement for short periods of time would result in similar findings. Indeed, findings by Kononova et al. (2016) suggested that forced disengagement from a text result in worse reading outcomes compared to voluntary task-switching.

No comparisons between print and e-reading were conducted, and so it is not clear to what extent short reading engagements are a characteristic of electronic rather than print reading. Although we are not aware of studies on continuous engagement durations outside of the lab during print reading, previous interview studies have suggested that print reading may be a more intentional and time-intensive activity. For example, interviewees in a study by Kosch et al. (2021) reported that electronic reading is not distractible in itself, however, the form factor of electronic texts make reading a possibility in a variety of scenarios, including environments in which the reader is frequently interrupted. In contrast, print was the preferred medium for more difficult and literary texts that require more intensive focus (Kosch et al., 2021; Schwabe et al., 2022). Accordingly, the short continuous engagements observed in our studies may not be an indicator of negative effects of electronic texts, but instead, they may reflect the situations in which adults naturally engage in e-reading.

In addition to task-switching, mind-wandering is a common cause for distractions during reading. For example, a study by Reichle et al. (2010) showed that readers mind-wandered for 9% of the time they spent reading a classic novel. Mind-wandering could not be measured directly with the e-reader system, however, it may have influenced participants' reading speed in the studies. Participants were 'slow reading' the text at a speed below 100wpm (words per minute), on average, 2-5% of the time. Considering that reading speeds below 100wpm for English texts have been found to be rare if the reader is fluent in English

(Brysbaert, 2019), the participants may have mind-wandered during these slow reading phases.

7.2.3 Text Navigation

Findings from Chapter 4 and 5 suggested that, on average, 74-82% of the text was read at a deep reading speed. We defined deep reading as the rate with which the text could be read with full comprehension. It was determined based on participants' baseline reading speed captured in a short test at the beginning of the two studies. Participants' average deep reading speed in the test was 253-306wpm (*SD* = 109-118wpm). The finding is in line with Brysbaert (2019) who found an average reading rate of 260wpm for English narrative texts.

The average deep reading rate during the studies was slightly higher than the baseline (*M* = 305-373wpm, *SD* = 107-184wpm). Indeed, variation in deep reading speed was common (see Figures 4.3B and 5.9), with participants moving between speeds as slow as 0.14 times their baseline to speeds 2.4 times faster than baseline. Similar rates of variance in reading speed were reported by Nell (1988a) during a lab-based observation study of print reading speed. Their findings suggested that readers speed varied from 115wpm all the way to 2214wpm during 30 minutes of reading. Participants' baseline test result and their observed speed average were significantly positively correlated, $r = .625\text{-}.676$, $p < .001$, suggesting that participants who used a higher reading speed during the study, also had a higher reading rate in the baseline reading speed test.

Reading speed was highly variant also beyond slow reading and deep reading. On average, participants used 'skim reading' 3% of the time, they 'scanned' the text 2% of the time, and .4% of the time was used for browsing the text (see Table 2.1 for the thresholds). Findings from Wohl and Fine (2017) showed that skimming and scanning text have an important role in reading academic texts, however, little previous research is available for frequency of reading narrative fiction at speeds beyond deep reading. These speeds may have been used for a variety of purposes: participants may have read parts of the text faster if they became highly engaged with the narrative, or they may have wished to skip ahead to avoid an uninteresting section. Browsing, on the other hand, may have been used to move around the text and explore its structure. Future research is needed to pinpoint the motivations behind different reading speeds during recreational reading, however, our findings show that overall reading speeds beyond deep reading are common in fiction reading.

In addition to reading speed, participants varied their linearity of reading. On average, 11% of all navigation during book reading and 13% of all navigation during short story reading was nonlinear, either backwards in text or forwards beyond the next page. All but one participant made use of regressions, of which 60% during book reading and 80% during story reading were to the previous page, and 16% and 3.8% were further than 3 pages away from the readers' chronological position in text. Forward leaps could be done by either browsing pages on the e-reader system or by making use of the progress bar at the bottom of the page (see Figures 3.2 and 5.5). Half of the participants made use of forward leaps. Most of these forward leaps were a couple pages forward from the most chronological position (33% during book reading and 50% during story reading), however, forward leaps from the beginning to the end of the text were also common (see horizontal lines in Figures 4.3C and 5.13).

These findings are in contrast to eye-tracking studies that have suggested such long-ranging nonlinear navigation to be rare (e.g., Rayner, 1998; Weger & Inhoff, 2007). As a result, few lab-based reading studies allow participants to navigate texts as they wish, and instead, the reader cannot return to previous pages or skip ahead (e.g., see Faber, Krasich, et al., 2020). However, our findings suggest that nonlinear navigation on the page-level is common during reading of fiction. Similar discoveries have been made in interview studies, as readers have described using regressions to previous pages to reread text and forward leaps to explore text structure and to avoid uninteresting sections (Garces-bacsal & Yeo, 2017; Milne, 2021).

7.3 RQ1: Connection Between Reader Characteristics and Reading Behaviour

Reader characteristics, including reading motivation, TR-EEXP, and demographics, were measured by questionnaires. Their connection to reading behaviour was assessed by multilevel models. See Table 7.1 for an overview of our hypotheses and results.

Table 7.1

Summary of Hypotheses and Results on Reader Characteristics

	Higher reading persistence	Higher reading frequency	Lower task-switching frequency	Baseline-level and slower reading speed when situational competence is low	More frequent nonlinear navigation when situational competence is low
Situational autonomous motivation is connected to...	H1.1a	H1.1b	H1.1c	H1.1d	H1.1e
Contextual autonomous motivation is connected to...	H1.2a	H1.2b	H1.2c	H1.2d	H1.2e
Task-relevant electronic reading experience is connected to...	H1.3a	H1.3b	H1.3c	H1.3d	H1.3e

Note. The colours in the table reflect whether the hypotheses were supported or not. Green: hypothesis supported, Grey: hypothesis not supported - no effect, Yellow: hypothesis partially supported

7.3.1 Reading Motivation

Findings from the three studies showed that the participants were overall highly contextually motivated to read for leisure. Average scores on the Intrinsic Motivation Inventory on Reading (IMI-R) developed by Fulmer and Frijters (2011) were 5-6.3 (out of 7 points) in the three studies. This is considerably higher than findings by Fulmer and Frijters (2011), which showed that children had an average IMI-R interest score of 2.7[16]. Overall, this suggests that participants were generally autonomously motivated in the contextual level.

Participants' contextual motivation was significantly associated with their self-reported recreational reading frequency and amount, indicating that participants who were more autonomously motivated to read for pleasure also did so more frequently. In contrast, no connection was found between contextual motivation and work reading frequency. These results are in line with previous research which suggested that autonomous reading

[16] IMI-R was modified for use with adults, and we are not aware of previous research that have assessed contextual motivation using IMI-R in adult samples.

motivation is connected to higher recreational but not work or school related reading frequency (Acheson et al., 2008; Mar & Rain, 2015; Pfost et al., 2013).

Similarly, average situational motivation was high across our three studies. Situational motivation was measured in Chapters 4 and 5 by the Intrinsic Motivation Inventory (IMI) developed by Deci and Ryan (1985). In Chapter 6, on the other hand, situational motivation was measured by asking participants to reflect on their enjoyment of 20 different books mentioned in their Amazon Kindle user data. The average situational motivation score was 4.9 and 5.9 in Chapters 4 and 5 (on a 7-point scale) and 4 in Chapter 6 (on a 5-point scale). These values are high compared to previous research (e.g., Tulis & Fulmer, 2013). As a result, participants generally enjoyed the books they read in the studies, and they were autonomously motivated to read them.

7.3.1.1 RQ1.1: Is Situational Motivation Connected to Reading Behaviour?

The findings showed that more autonomous situational motivation was connected to higher reading persistence and higher reading frequency, in accordance with our hypotheses H1.1a and H1.1b (see Table 7.1). This indicates that participants who were more motivated to read the text in the study also returned to it more frequently, and they were more likely to read it until the end.

The results were not consistent between the three studies. The result on reading persistence was found in Chapter 5 and frequency was connected to situational motivation in Chapter 6. Findings from Chapter 4, on the other hand, did not support any of our hypotheses on the connection between situational motivation and reading behaviour. These inconsistencies in the results could be due to differences between the study designs. In Chapter 4, situational motivation was manipulated by text selection. Although the manipulation significantly influenced motivation scores, it may have not been practically significant: the participants in the two conditions differed in their situational motivation scores only by .8 points (in a 7-point scale). The limited effect of the manipulation may have been due to the monetary compensation used in the study, which previous studies have found to bias situational motivation (Deci et al., 1999). In Chapter 5, on the other hand, the sample was affected by considerable dropout rates. Participants were asked to read their selected book until the infographic threshold (approx. 70 pages) before responding to the final questionnaires, including IMI. It is possible that participants with little situational motivation were less likely to reach the infographic threshold, limiting our analyses. Finally, in Chapter 6, situational motivation was only measured from the 20 books that participants had spent the most time reading. Considering that readers are likely to spend more time on books that they are most interested in (Fulmer & Frijters, 2011), the self-reports may have been focused on the books that participants were the most motivated to read. These ceiling effects across the studies could have lowered the reliability of our findings, and it may partly explain why the results were not replicated.

Whereas reading frequency and persistence were connected to situational motivation, task-switching frequency, reading speed, and linearity were not associated with it, contrary to our expectations. This indicates that motivation to read a particular text may not influence text navigation or the frequency of disengagements. This is surprising considering that previous research has connected enjoyment of a story to immersive experiences that can support extended reading engagement and make the reader less vulnerable for distractions (McQuillan & Conde, 1996). Furthermore, motivation has been suggested to play a part in text comprehension: findings by Milne (2021) indicated that motivation to read a text can support careful reading of the text, and so the motivated reader is more likely to reread complex sections of the text and vary their reading speed in relation to text demands. It is possible that the ceiling effects in situational motivation masked these effects in our sample.

7.3.1.2 RQ1.2: Is Contextual Motivation Connected to Reading Behaviour?

Similarly to situational motivation, we expected more autonomous contextual motivation to support participants' reading engagement (see Table 7.1). The findings showed that more autonomous contextual motivation was connected to lower task-switching frequency (Chapter 4), higher reading frequency (Chapter 5), and baseline-level and slower reading speed when the text was perceived to be difficult (Chapter 4).

Overall, the results suggest that participants with more motivation towards reading as an activity returned to the book more frequently, they disengaged from the text less often, and they readily reacted to text difficulty by adapting their reading speed. The first finding may reflect avid readers' enjoyment of reading as an activity, which may have led them to return to the book frequently. In contrast, participants with lower levels of contextual motivation may have seen reading as a time-intensive and effortful activity, similarly to the infrequent readers in a study by Wilkinson et al. (2020). Differences in reading speed and task-switching, on the other hand, may partly reflect the contextually motivated participants' deeper engagement with narratives. Findings by Rosa and Lehtimäki (2021) suggested that motivated readers imagine stories vividly which helps them to get immersed in the story. This may result in long continuous engagements, but also a heightened sense of awareness of the text demands (Maier & Richter, 2014; Rosenthal, 1995; Zimmerman & Moylan, 2009).

Reading persistence, on the other hand, was not connected to contextual motivation. This is surprising considering that previous research has shown that avid readers tend to have an internal locus of control and therefore they feel that their enjoyment of the text is contingent on the effort they put into reading it (Keller & Blomann, 2008). In contrast, participants with more controlled contextual motivation tend to expect that the text should feel immersive to them from the very beginning, causing them to stop reading if this was not the case. Instead of contextual motivation, reading persistence was associated with participants' print exposure score in Chapter 5. Print exposure is often linked to reading motivation, and many view it as a self-report measure of reading frequency that is robust against social desirability bias (see Mol & Bus, 2011). However, our finding suggests that print exposure may be associated with behaviour beyond its connection with motivation.

Overall, the findings suggest that contextual motivation may support reading engagement. However, it is important to note that the results were not consistent across the three studies. Only a non-significant trend was found between more autonomous contextual motivation, higher reading frequency, and lower task-switching frequency in Chapter 6. Furthermore, the effects observed in Chapters 4 were not replicated in Chapter 5, and vice versa.

One reason for this is the overall high level of contextual motivation in the studies. Participating in the studies may have been more attractive for adults who are more autonomously motivated to read for pleasure. This makes sense, as we used convenience sampling across all three studies, and individuals with controlled contextual motivation may be reluctant to take part in any reading tasks.

The study presented in Chapter 4 resulted in the lowest contextual motivation average (5 points on a 7-point scale, compared to 6.3 in Chapter 5, and 4 on a 5-point scale in Chapter 6), potentially due to the monetary compensation used. The compensation may have appealed to participants regardless of their contextual motivation, whereas receiving an infographic on their own reading behaviour in Chapter 5 may have been primarily attractive to participants with existing autonomous motivation to read. In Chapter 6, on the other hand, we collected data only from adults who had used Amazon Kindle devices or applications for reading. Considering that these individuals had sought out a reading platform in their own time, it made sense that they scored highly in contextual motivation. Similarly to situational motivation, these ceiling effects may have made it difficult to capture variation in reading behaviour in relation to contextual motivation.

7.3.2 Electronic Reading Experience

Participants were generally experienced in using digital devices and they had access, on average, to 2-3 different devices, most often a smartphone, laptop, and a tablet computer or a dedicated e-ink e-reader. Participants in Chapters 5 and 6 indicated that they read print and electronic books equally often, whereas in Chapter 4 print books were slightly more popular than electronic texts.

We expected task-relevant electronic reading experience (TR-EEXP) to support reading engagement on digital devices. TR-EEXP was measured by two variables: (1) frequency of reading task-relevant texts [17] on any digital devices, and (2) frequency of using task-relevant digital devices [18] to read any electronic text. Neither type of TR-EEXP was expected to support reading engagement without the other: whereas low experience with task-relevant devices has been connected to difficulty using the device and vulnerability to the distractions (Vernon, 2006; Yoo & Roh, 2019), little experience in reading long-form narrative fiction electronically has been suggested to result in the shallowing effect if the individual is accustomed to accessing only short-form and immediate content electronically (Gezgin et al., 2021).

The findings showed that the participants in Chapters 5 and 6 had experience in reading task-relevant text types electronically but they were not used to using task-relevant digital devices for reading purposes. In Chapter 4, on the other hand, the pattern was the opposite, and so participants were slightly less used to reading narrative long-form fiction electronically, but they had more experience with task-relevant digital devices in other

[17] Task-relevant text types were narrative long-form fiction, either short stories or novels

[18] Task-relevant devices were those that could be used to access the e-reader system (smartphone, laptop, PC, or tablet computer), or devices that could be used to read on Amazon Kindle: dedicated e-ink e-reader, smartphone, laptop, PC, or tablet computer

reading tasks. Overall, TR-EEXP was modest across the three studies: participants reported using task-relevant digital devices for reading only 'a few times a year' and they read task-relevant text types electronically 'a few times a year' or 'a few times a month'.

7.3.2.1 RQ1.3: Is Task-relevant Electronic Reading Experience Connected to Reading Behaviour?

Findings from Chapter 4 indicated that TR-EEXP was associated with variance in reading speed and linearity of reading. Participants with more task-relevant electronic reading experience adjusted their reading speed more adaptively in relation to perceived text difficulty; whereas difficult texts were read at a baseline-level and slower speed, easy texts could be read at a higher rate. Furthermore, those experienced with task-relevant text types and digital devices used overall less frequent nonlinear navigation. These findings suggest that TR-EEXP may support readers' text navigation electronically.

However, the findings were not replicated in Chapters 5 and 6. Instead, results from Chapter 5 suggested that participants who reported reading task-relevant texts more frequently were less likely to persist in reading their selected book, they task-switched more frequently, and read their selected text with an overall faster reading speed compared to participants with little experience of reading narrative long-form texts electronically. This pattern of results could be connected to the alternative reading materials that participants had available. For example, findings by Braslavski, Likhosherstov, et al. (2016) suggested that abundance of competing materials electronically can result in low reading persistence. Furthermore, the e-reader system may have not compared well to the commercial electronic reading platforms that these participants were used to using. As a result, these readers may have felt more distractible, and wished to finish the text quickly by reading it with a faster speed.

Overall, the results suggest that TR-EEXP may play a role in electronic reading engagement. However, as the results were not consistent across the studies, more research is needed on the role of electronic reading experience. Few previous studies have taken electronic reading experience into account, even though the prevalence of print reading has been widely documented, and many acknowledge the different strategies required for reading electronic rather than print texts (D'Ambra et al., 2019; Mangen et al., 2019). Findings by Vernon (2006) showed that the majority have limited electronic reading experience, whereas

Yoo and Roh (2019) showed that these individuals' print-reliant reading strategies can cause them to struggle with electronic reading mediums. Considering the widespread nature of e-books and the positive potential electronic platforms have for making reading more widely available, more research is needed on identifying how electronic experience can influence reading behaviour, and how adults could be supported in reading on digital devices.

7.3.3 Connection Between Other Reader Characteristics and Reading Behaviour

Previous research has shown that text complexity plays an important role in how the text is read. Findings by Berger et al. (2023) showed that easier texts are more likely to capture the reader's attention, whereas Teravainen-Goff et al. (2022) indicated that difficult texts are often left unfinished. In accordance, situational competence, indicating of participants' perception of the text difficulty, was connected to reading behaviour in Chapters 4 and 5. Participants who perceived the text to be easier to read were less likely to task-switch during reading it (Chapter 4), and they returned to it more often (Chapter 5). It is possible that participants who found the text more difficult to read were not as eager to pick it up as often, and they may have needed more frequent breaks during reading it. Indeed, adults tend to prefer reading easy texts over difficult literary texts (Locher et al., 2019; Nell, 1988a).

In addition to situational competence, contextual competence, indicative of participants' perception of their own reading ability, was connected to reading behaviour. Findings from Chapter 4 suggested that those who perceived their reading ability to be high engaged in more frequent task-switching, and they read the short story at an overall higher reading speed. In Chapter 5, on the other hand, high contextual competence was connected to low reading persistence and high reading frequency. Only the last effect can be easily explained, as previous research has indicated that reading skill and self-efficacy can encourage frequent reading engagement (Howard et al., 2021; Wigfield & Guthrie, 1997). High task-switching frequency, reading speed, and low reading persistence, on the other hand, could potentially reflect boredom. If the participants found the reading task too easy and unengaging, they may have struggled to remain focused on it, and thus they may have used a faster pace to finish the text quickly.

Connections were also made between participants' demographics and their reading behaviour. Findings from Chapter 5 showed that age was significantly, positively associated with continuous engagement durations, and so older adults were less likely to task-switch during reading of their selected book. This may indicate higher patience for the reading task, as suggested by Keller and Blomann (2008). The way the text was navigated was not connected to age, and therefore, no evidence was found to support the ‘digital native’ hypothesis which suggests that young adults are experienced with electronic environments, and so they can navigate them with ease (Kirschner & De Bruyckere, 2017).

Results on gender, on the other hand, suggested that men task-switched more frequently (Chapter 6) and used nonlinear navigation more often compared to women (Chapter 5). These effects may reflect differences in reading motives: previous studies have suggested that women are more likely to read because they wish to be immersed in a story, whereas men may strive to learn something new (Jabbar & Warraich, 2022; Liu & Huang, 2008). Accordingly, men may have read the text more selectively, whereas women may have preferred to focus for extended periods of time.

Finally, participants’ education level and native language were connected to reading behaviour. The findings showed that highly educated readers used an overall faster reading speed, and non-native English speakers were less likely to persist in reading their selected book. The latter effect could be due to language skills if the non-native participants found the text more difficult to read. Previous research has suggested that higher level of education is often connected to more frequent reading engagement (GfK, 2017; Rogiers et al., 2020), however, it is unclear why participants with high level of education would have made use of faster reading speeds relative to their baseline.

7.4 RQ2: Connection Between Task-contexts and Reading Behaviour

Multilevel models on task-contexts were used to assess how reading behaviour was connected to device, reading location, location in text, reading session number, time since the beginning of the reading session, and previous reading behaviour. See Table 7.2 for an overview of our hypotheses and results.

Table 7.2

Summary of Hypotheses and Results on Task-contexts

	Higher reading frequency	Higher task-switching frequency	Baseline-level and slower reading speed	More frequent nonlinear navigation
Reading location outside of the home is connected to...	H2.1a	H2.1b	H2.1c	H2.1d
Early reading sessions are connected to...		H2.2a	H2.2b	H2.2c
Early locations in text are connected to....		H2.3a	H2.3b	H2.3c
The beginning of reading sessions is connected to...		H2.4a	H2.4b	H2.4c

Note. The colours in the table reflect whether the hypotheses were supported or not. Green: hypothesis supported, Red: hypothesis not supported - opposite effect, Grey: hypothesis not supported - no effect, Yellow: hypothesis partially supported

7.4.1 Devices Used

Device usage varied between the studies, as the majority of participants in Chapter 4 relied on large digital devices, such as laptops or PCs, to read their assigned short story, whereas findings from Chapter 5 showed that most of the participants read their selected novel on a small device, such as a smartphone. Findings from Kosch et al. (2021) suggested that this difference could reflect differences in how participants perceived the reading task and how they tend use their devices: whereas some devices are associated more with work, others are connected to leisure activities and preferred for recreational reading. Overall, findings by Kosch et al. (2021) suggested that interviewees preferred dedicated e-ink e-readers for electronic reading. A similar pattern was found in Chapter 6, as 54.8% of reading sessions were recorded on e-ink e-readers instead of general-purpose devices.

In Chapters 4 and 5, device was assessed by participants' browser window width. When the e-reader system was used on a small device, such as a smartphone, the text was presented in one column, whereas larger devices with a full-screen browser window presented the text in two columns (see Figure 3.2). Findings from Chapter 5 suggested that larger devices were associated with an overall faster reading speed and more frequent nonlinear navigation. The result may reflect differences in text layout. Findings by Dyson and Haselgrove (2001) showed that longer lines of text can make text more difficult to comprehend, forcing the reader to backtrack in text more often. Furthermore, Dyson and Haselgrove (2001) suggested that large amounts of text can feel overwhelming to the reader, encouraging skimming and nonlinear navigation.

In Chapter 6, device was assessed by a binary indicator of whether the device was a dedicated e-ink e-reader or a general-purpose device. The findings showed that dedicated e-ink e-readers were connected to less frequent task-switching, compared to general-purpose devices. E-ink e-readers offer fewer affordances compared to general-purpose devices, such as smartphones, and so they are likely to pose fewer distractions to the reader. These findings were echoed in interviews by Kosch et al. (2021) as the readers reported that they find that competing applications and incoming notifications on smartphones distract them from reading, whereas e-ink e-reader can support extended reading engagement, similarly to print books.

7.4.2 RQ2.1: Is Reading Location Connected to Reading Behaviour?

Reading location outside of the home was expected to result in different reading behaviour than reading at home. Indeed, findings from Chapter 5 showed that reading on the go was associated with more frequent task-switching than sessions at home. Reading outside of the home may have been more distractible, especially if the reading task was a secondary activity during a commute or while waiting for an appointment. We expected that this flexible reading engagement would result in more frequent reading sessions, however, this hypothesis was not supported. Instead, participants engaged in reading equally often regardless of their reading location, suggesting that reading outside of the home does not occur in addition to reading sessions at home. Interview studies have suggested, in fact, that although avid readers generally prefer reading in the comfort of their home, they would rather engage in reading on the go than simply read less on busy days (Kosch et al., 2021; Merga, 2017b).

The findings suggested that reading outside of the home was not only connected to more frequent task-switching, but also more frequent nonlinear navigation. It is possible that two effects are linked: participants may have used nonlinear navigation to reread text after a disengagement, as suggested by findings from Chevet et al. (2022).

7.4.3 RQ2.2: Are Location in Text and Timing of Reading Sessions Connected to Reading Behaviour?

Previous research has suggested that the beginning of narrative fiction places more demands on the reader compared to the middle, or the end (Rosenthal, 1995; Syd Field, 2005). Accordingly, we expected participants to find the beginning of the reading task more challenging compared to the end, and thus they were expected to task-switch more often (H2.2a and H2.3a), and use a slower reading speed (H2.2b and H2.3b), and more frequent nonlinear navigation (H2.2c and H2.3c) in early reading sessions and early locations in text.

Findings from Chapters 4 and 5 indicated that early locations in text were indeed associated with slower reading speed, which then increased towards the end of the text. Similar results have been reported in eye-tracking research (e.g., Demberg & Keller, 2008; Kaakinen et al., 2018; Kuperman et al., 2010). Over time, readers become familiar with the author's writing style and story narrative, which should make it possible for them to read the text at a faster speed. Furthermore, reading speed may increase in anticipation of finishing the reading task (Demberg & Keller, 2008), or due to immersion (McQuillan & Conde, 1996). The latter becomes increasingly likely towards the end of the text as fiction tends to follow a predictable story arc that becomes gripping towards the climax (Syd Field, 2005).

Additionally, the findings showed that the participants disengaged from the text and navigated it nonlinearly at the beginning of the reading task. Participants in Chapter 5 task-switched more frequently in early rather than late reading sessions, suggesting that they may have struggled to engage with the text at first. Nonlinear navigation in early reading sessions, on the other hand, may have reflected exploration of the text structure before committing to reading it, a reading pattern that was also described by Martin-Chang et al. (2020).

7.4.4 RQ2.3: Is Time Since the Beginning of a Reading Session Connected to Reading Behaviour?

In addition to timing of reading sessions and location in text, we expected that reading behaviour would vary *within* reading sessions. Interview studies have suggested that readers may struggle to settle down to read a book in the beginning of reading sessions (e.g., Rosenthal, 1995), and accordingly, we expected that the beginning of reading sessions would be connected to more frequent task-switching, a slower reading speed, and more frequent nonlinear navigation.

Findings from Chapter 4 and 5 showed that nonlinear navigation was more common in the beginning of reading sessions, supporting our hypothesis H2.4c. It is possible that the readers used nonlinearity to look back in the text and remind themselves about where they left off before resuming reading. Furthermore, the finding was qualified by an interaction in Chapter 5, which suggested that nonlinear navigation was most likely in the beginning of reading sessions if the participant was also at the beginning of the text. This suggests that nonlinearity was primarily needed when the text content was still unfamiliar.

Finally, results from Chapter 5 showed that task-switching was more frequent at the end rather than the beginning of reading sessions, contrary to our hypothesis H2.4a. As a result, participants felt increasingly distractible later on in the reading sessions. This may be indicative of fatigue; as an effortful activity, the participants may have struggled to maintain their attention on the text over long periods of time.

7.4.5 RQ2.4: Can We Predict Reading Behaviour by Previous Events?

No hypotheses were set on the connection between participants' reading behaviour at $Event_k$ and $Event_{k-1}$ and $Event_{k-2}$. However, it was considered to be worthwhile studying considering the potential for future research: if individuals' reading behaviour can be predicted by their earlier engagement, forecasting how reading behaviour will vary in the future becomes a possibility. As a result, it could be possible to categorise behaviour into reader profiles and identify when a reader is struggling with a text.

The findings showed that participants' task-switching frequency, reading speed, and linearity of reading were connected to reading behaviour at $Event_{k-1}$ and $Event_{k-2}$. Participants were found to either engage continuously for long periods of time or alternate between frequent task-switching and long continuous engagements. This may indicate differences in preference for task-switching, as previous research has shown that some individuals generally prefer frequent task-switching over long engagements, whereas others enjoy focusing on a single activity at a time (Kononova et al., 2016). Reading speed, on the other hand, was positively associated with speed at events *k-1* and *k-2*, suggesting that any variation in speed was likely to be gradual.

Whereas findings on task-switching and speed were in agreement across the studies, results on linearity of reading converged. In Chapter 4, nonlinear navigation was more likely at $Event_k$ (the outcome variable) if the previous event (*k-1*) did not initiate nonlinear navigation. This suggests that readers did not move between different types of nonlinear navigation, i.e. regressions and forward leaps, in consecutive page-views. Findings from Chapter 5, on the other hand, suggested that nonlinearity at $Event_{k-1}$ and $Event_{k-2}$ increased rather than decreased the likelihood of nonlinear navigation $Event_k$. This suggests that the participants in the two studies may have used nonlinear navigation for different purposes. For example, in Chapter 4 participants may have mainly used short-range regressions to reread the previous page, whereas in Chapter 5 participants may have used nonlinearity to move from the beginning of the text to the end. These differences may be driven by participants' motives for nonlinear navigation, which should be studied further in future research.

7.5 A Preliminary Conceptual Cognitive Model of e-Reading Behaviour

To enhance our understanding of adults' e-reading behaviour, we create a preliminary conceptual cognitive model on the basis of the three studies. Essentially, this cognitive model is an approximation of how an average participant read a text electronically on the e-Reader System (Chapters 4 and 5) or on their Amazon Kindle devices and applications (Chapter 6). The model is preliminary considering that the results did not fully replicate across the three studies, and so future studies are needed to further inform the model. However, even in its preliminary state, this coherent representation of adults' e-reading behaviour is useful for informing future study and in predicting how adults' reading behaviour varies electronically.

Recreational reading often begins in book browsing (McKay et al., 2021). Previous studies have shown that text selection and book browsing are complex tasks that involve several behaviours (e.g., McKay et al., 2019; Puspitasari, 2019). Similarly, our findings from Chapter 5 suggested that electronic text selection may not be a straightforward action: participants spent, on average, 33 minutes browsing different options on the e-Reader System and they viewed information on three different books. Although text selection was not our focus in this thesis and thus it should be studied further in future studies, our findings indicated that despite of the time the participants spent on selecting their reading materials, they may be surprised by their selected text. For example, in Chapter 4, 43% of participants ended up enjoying a short story of which summary they rated as uninteresting.

When the participants started reading their selected text, they had a tendency to read it at a slower than baseline deep reading speed, they frequently task-switched during reading, and they were likely to navigate text nonlinearly. Narrative texts tend to follow a predictable story structure (Brütsch, 2015), where the plot, the story setting, and characters' relationships are established in the beginning (Syd Field, 2005). This can feel effortful to read, and so the readers may need to use a slower than usual reading speed. Similarly, task-switching may be more common in the beginning of a text if a reader becomes fatigued quickly and needs short breaks to maintain their attention, as suggested by findings from Ariga and Lleras (2011). Alternatively, frequent task-switching at the beginning of text may reflect of participants' low immersion in the story: reading flow is unlikely to occur if the reader is not familiar with the story world, and so they may feel vulnerable to distractions (McQuillan & Conde, 1996). Nonlinear navigation at the beginning of the text, on the other hand, was suggested by Martin-Chang et al. (2020) to reflect an adaptable strategy to explore the story structure before committing to reading it.

In the beginning of the reading activity, participants returned to their selected text frequently. This may indicate of high initial interest in reading the text, which may have waned over time. It is plausible to expect that readers feel excited to begin a new book, but their interest may plummet if they find it difficult to connect with the narrative. Indeed, situational motivation was positively associated with participants' reading persistence, suggesting that readers who felt more autonomously motivated to read their selected text were more likely to continue reading it further.

The middle of a text is likely to feel more engaging as a conflict is introduced to the reader (Syd Field 2005). We found that participants returned to the text, on average, every 3 days and they engaged continuously for 10 minutes at a time before disengaging from the text. These averages were influenced by both reader characteristics and task-context. In terms of the former, we found that situationally and contextually motivated participants returned to the text more frequently. These findings are in line with previous self-report studies that have shown a robust connection between reading motivation and frequency (e.g., Van Ammel et al., 2021; Nolan-Stinson, 2008). Furthermore, avid readers with more autonomous contextual motivation task-switched less often when reading the text. It is possible that these habitual readers' high motivation towards reading as an activity supported their attention in the reading task, despite of their situational motivation towards the text. Alternatively, avid readers may be more practiced in retaining their attention on a text.

The perceived difficulty of a text was connected to participants' reading behaviour. Participants who found the text easy to read returned to it more frequently and they task-switched less often during reading it. Indeed, easy texts may support readers' attention better than difficult reading material, which may explain why readers tend to prefer reading texts below their reading skill level (Locher et al., 2019; Nell, 1988a).

Previous studies have shown the importance of rereading text and slowing down one's reading speed when the text is difficult (e.g., Schotter et al., 2014; Brysbaert, 2019). However, our findings from Chapter 4 suggested that motivation and electronic reading experience have an effect on whether readers make use of these important reading strategies. Contextually motivated participants were more likely to slow down their reading speed and navigate text nonlinearly when the text was perceived to be difficult, whereas those who were less motivated towards reading as an activity were more likely to ignore the importance of rereading and slower reading. Electronic experience, on the other hand, was connected to slower reading speeds when text was perceived to be difficult. It is possible that contextual motivation encourages careful reading of text, whereas electronic experience may contribute to readers' understanding of their own reading comprehension levels.

Reading sessions lasted, on average, for 32-47 minutes and they usually occurred in the participants' home. The findings showed that reading outside of one's home was connected to more frequent task-switching, however, reading behaviour was not otherwise influenced by the reading location. Instead, reading behaviour seemed to vary in relation to timing within a reading session: when the participants settled down to resume reading their selected text, they read at a slower speed, and they used frequent nonlinear navigation. It is possible that participants needed to reread previously read sections of the text to catch up on where they left off in the story, similarly to behaviour seen in a study by Iqbal and Horvitz (2007). At the end of the reading sessions, on the other hand, participants task-switched frequently, potentially due to fatigue.

At the end of the text, the plot reaches its climax (Syd Field, 2005). This may feel particularly engaging for the reader, and accordingly, we found that participants' reading frequency increased towards the end of the text. Furthermore, participants' reading speed increased towards the end, which may indicate of a higher likelihood of reading flow that allows the readers to neglect any task-irrelevant distractions (McQuillan & Conde, 1996).

Not all readers reach the end of the book, however. In Chapter 5, only 42% of the participants read more than 90% of their selected book, and on average, the book was read only 53% of the way through. As mentioned earlier, situational motivation towards a book was positively associated with reading persistence, and so participants who were more motivated to read the book were more likely to finish reading it. Furthermore, reading persistence was connected to participants' age and gender: older participants and women were more likely to persist in reading the book for longer.

Whereas in Chapter 5 persistence was found to be low, all but two participants finished the short story in Chapter 4. This pattern of results may be due to the different length of the reading material used in the two studies: whereas the 15-24-page short stories could have been read within an hour, reading one of the full-length novels used in Chapter 5 would have required a considerable time investment. This suggests that shorter texts may be more likely to be finished. Alternatively, the difference could have been due to the monetary compensation used in Chapter 4. Rewards influence readers' motivation, and it can make them feel responsible for completing the task (Deci et al., 1999). Although monetary reward may have supported the participants in finishing the text in full, findings from Deci et al. (1999) showed that a reward may have a negative effect on motivation.

7.5.1 Individual Variation in Reading Behaviour

Identifying commonalities in adults' electronic reading behaviour allows us to make predictions on the ways in which adults e-read in an effort inform development of interventions. However, across the three studies we saw considerable variation in adults' reading behaviour that was not fully accounted for by reader characteristics and task-context predictors. For example, in Chapter 5, participants spent between 1 minute and 21 hours reading on the e-Reader System, and they disengaged from the text 1-92 times. Similarly, in Chapter 6, participants had spent anything between 1 minute and 3,729 hours reading on their Amazon Kindle devices and applications, and they read 1 to 1,106 different books. This variance occurs despite of the fact that the samples mostly consisted of highly educated and motivated readers. Reducing this considerable variation into aggregates would bias our understanding of adults' reading behaviour, and so it is necessary to study the uniqueness of adults' reading practices, in addition to areas of commonality.

7.6 Future Research and Limitations

This thesis provides novel information on adults' recreational e-reading behaviour across multiple different devices. The results demonstrate the potential in unobtrusive observation for studying reading behaviour outside of the lab. The findings serve as a foundation for future research which is needed to develop effective reading promotions to increase adults' reading engagement.

Our assessment of motivation and TR-EEXP was limited by the convenience sampling used. In Chapter 4 we were able to recruit participants with varying levels of contextual motivation and TR-EEXP due to the monetary compensation used, however, this method biased our evaluation of situational motivation. In Chapters 5 and 6, on the other hand, the sample was largely limited to participants with existing autonomous contextual motivation and high levels of TR-EEXP, which made it difficult to assess the connection between reading behaviour and these reader characteristics. Recruitment of infrequent and reluctant readers to reading studies has been recognised as a challenge (Gauder et al., 2007), however, considering the key role of motivation in reading engagement, future research is needed to study adults' reading behaviour in samples that are more representative of the population, for example, by making use of groups or clusters similarly to reading research conducted within school settings.

Future studies should assess text selection processes in relation to reading motivation, TR-EEXP, and reading behaviour. Previous studies have showcased that autonomy in text selection is important for reading motivation (e.g., Ivey & Johnston, 2013), however, autonomy cannot guarantee that readers are competent in selecting appropriate reading materials. For example, findings by Spear-Swerling et al. (2010) suggested that infrequent readers were more likely to select expository and too difficult reading materials that turned out to be uninteresting to them, whereas avid readers were experienced in selecting which narrative text would maintain their reading motivation. Electronic text selection may place additional demands on the individual as the number of available options can be overwhelming (D'Ambra et al., 2019; McKay et al., 2018). Findings by Kosch et al. (2021) showed that electronically experienced readers tend to select different types of books to read electronically and on print. Whereas narrative fiction was likely to be read as an e-book, the interviewees indicated that they prefer to read more complex material and nonfiction in print.

It is unclear to what extent infrequent readers' text selection electronically would be in line with that of avid and electronically experienced readers.

Reader characteristics and task-contexts were studied separately with two multilevel models, however, in reality, the effect of reader characteristics and the context in which a text is read are likely to be intertwined. For example, previous research has suggested that avid readers yearn to read more often, and so they may read books frequently in a variety of locations (Nolan-Stinson, 2008), suggesting that reading motivation should be studied in connection to reading locations. Similarly, TR-EEXP may be connected to task-contexts as participants' familiarity with the reading format can influence the ways in which they navigate electronic texts. Findings by Yoo and Roh (2019) and Jian (2022) showed that readers with little experience of electronic texts may vary their reading behaviour across reading sessions and different locations in text unlike those with TR-EEXP: whereas experienced readers can make use of features in the reading platform to support their engagement, inexperienced readers may struggle to maintain their focus on the text towards the end of a reading session.

As a result, future research should aim to inspect reader characteristics and task-contexts in conjunction. This type of analysis goes beyond the capability of multilevel models, and thus, more intricate methodologies such as machine learning should be used to understand variation in reading behaviour. For example, this approach was successfully used by Chen et al. (2021) who employed machine learning to study behaviour during reading of lecture notes.

Assessment of text characteristics on each page-view would further enhance our understanding of the connection between reading behaviour and task-contexts. Findings from Magyari et al. (2020) showed that descriptive text passages resulted in longer fixation durations compared to more dynamic scenes. Similarly, garden-path sentences that confuse the reader and variation in text layout, such as line length, have been found to influence reading speed (Dyson & Haselgrove, 2001; Meseguer et al., 2002). Analysing reading behaviour in relation to text characteristics on each page-view has the potential to shed light on which circumstances individuals vary their reading patterns.

The majority of previous research on reading behaviour has made use of lab-based approaches that aim to control as much variance as possible to uncover the effect of variables of interest (Kingstone et al., 2008). However, complex processes such as recreational reading engagement occur within the context of this variance. Adults' reading behaviour is affected by their daily responsibilities and mood among many other incidental variables. By attempting to control as much of the variance as possible, behaviour can be distorted into something that would be unlikely to occur in participants' familiar environments (Kingstone et al., 2008; Risko & Kingstone, 2011).

Ecologically valid research approaches allow us an objective glimpse into the ways in which adults naturally read. However, as a trade-off, it was not possible to capture participants' reading experience beyond the behavioural level; although the e-Reader System could be used to accurately track behaviour on a page-view, we could not tell how adults' cognitive or affective engagement varied. For example, we expected participants to be reading the text when they were viewing a page on the e-Reader System. However, it is possible that the e-Reader System was simply left open while the participant was engaging in alternative tasks. Similarly, a page that was read at a slow speed may have been a result of rereading text on the page, mind-wandering, making notes on the text, or leaving the e-reader system open on a web-browser to get a cup of tea. Indeed, to make use of the objective tracking data, it was necessary to interpret it.

We aimed to use features in the e-Reader System to reduce these ambiguities in the tracking data and improve accuracy of our interpretations. For example, to distinguish between engagements and disengagements, we used a text masking function after 5 minutes of inactivity. However, it is unlikely that all idle time was correctly removed. The issue was exacerbated in Chapter 6 as the Amazon Kindle user data only included information about continuous engagements, and errors in the data suggested that not all information was accurate.

This trade-off between naturalistic research settings and noise in the data has been acknowledged in previous research. For example, Kingstone et al. (2008) point out that making sense of this variance and noise is key to understanding the complexity of human behaviour in natural environments. To manage the noise in studies such as ours and to capture reading experiences beyond the behavioural level, observational approaches should be used alongside other methodologies. This triangulation across multiple methodologies would allow us to capture adults' reading practices behaviourally, but also in relation to their cognitive and affective engagement with the text. This is key considering that research limited to the behavioural aspects of reading fail to capture reading engagement in its full complexity (Lee et al., 2021; Schmidt & Retelsdorf, 2016). Therefore, future studies should aim to use unobtrusive tracking alongside lab-based experimentation and self-reports. Whereas lab-based studies can tell us more about reading behaviour within a page, self-reports such as interviews can be used to capture variation in cognitive and affective reading engagement. Together these different methodologies can be used to create a comprehensive understanding of adults' reading behaviour.

Chapter 8

Conclusion

This thesis aimed to enhance our understanding of how adults read narrative texts on digital devices within the context of their everyday lives. Across three studies, information on reading behaviour was gathered from short story reading (Chapter 4), book reading (Chapter 5), and multiple text reading (Chapter 6) using two novel methodologies. This thesis made four main contributions:

1. Design and development of a novel method to measure e-reading behaviour unobtrusively. The e-reader web application allows detailed tracking of reading behaviour in an ecologically valid setting without bias from retrospective recall. The method provides a new way to assess reading behaviour and thus contributes to future research.

2. An in-depth understanding of adults' e-reading behaviour in their daily life on a variety of devices. The three experimental studies resulted in rich datasets that showcase how reading behaviour varies both within- and between-participants.

3. Evaluation of how behaviour is connected to the reader's characteristics to illustrate the connection between motivation, electronic reading experience, and reading behaviour. The findings contribute to existing results obtained from self-report and lab-based measures and showcase how unobtrusive observation can result in different results.

4. Exploration of the connection between task-contexts and e-reading behaviour showed that behaviour varies within-participants in relation to devices used, reading location, location in text and timing of reading sessions. The findings highlight the importance of considering task-contexts when assessing adults' reading engagement.

Findings from the three studies contribute to future research and inform development of effective reading promotions. Although specific approaches to increase reading engagement should be studied in future research, the findings can give direction on the type of interventions that are feasible. Our results showcase that adults' recreational reading behaviour is highly variant, suggesting that any single reading promotion may not fit everyone's needs. Adults engage in reading for leisure within the context of their daily lives, and these constraints should be taken into consideration when supporting them in incorporating more frequent reading sessions in their schedules. Our results showed that the average participant engaged in reading every 3 days and their continuous engagement only lasted for 10-15 minutes. As a result, encouraging flexible reading engagement around the individual's schedule may work better than a fixed approach that puts pressure on the individual to read for extended periods every day.

The variable reading behaviour illustrated in our studies suggests that future research should provide participants a possibility to navigate texts more freely. Previous research conducted in the lab has suggested that large-scale nonlinear navigation is uncommon (Rayner, 1998; Weger & Inhoff, 2007), whereas our findings on the page-level showed that approximately 11% of all navigation included nonlinear movement. Many lab-based studies on reading restrict participants' movement in the text, and so any large-scale nonlinearity cannot be captured. To enhance the ecological validity of lab-based studies, readers should be given the possibility to freely navigate their reading materials. This change would not only provide a more naturalistic reading environment, but it would allow the study of variation in participants' linearity of reading further.

Similarly, variation in reading speed should be studied in the future by providing participants a natural reading environment. Little is known about what causes readers to increase their speed at different sections of the text, however, this branch of research has not received much attention as reading speeds faster than deep reading are often considered to be noise and discarded from analyses. Studies presented in Chapters 4 and 5 indicated that participants used speeds faster than deep reading approximately 5% of the time, suggesting that this variation is not uncommon.

Our findings on the role of reader characteristics showed mixed results across our three studies. Situational motivation and electronic reading experience were not consistently connected to reading behaviour, potentially due to difficulty in measuring these variables. Contextual motivation and text difficulty were found to have a less ambiguous role in frequent reading engagement, however, the findings were limited by difficulty in recruiting balanced samples and issues in assessing text difficulty at multiple time points. Despite our mixed findings, previous studies have suggested that reading motivation and electronic experience have a considerable impact on the ways in which electronic books are read (Milne, 2021; Yoo & Roh, 2019; Zheng & Li, 2020). Considering that our findings were in the expected direction, and so in agreement with self-report findings, reading motivation and electronic reading experience should be studied further in future research.

Compared to reader characteristics, the connection between reading behaviour and task-contexts was found to be more robust. The results showed that reading behaviour varied in relation to the device used and reading location, suggesting that reading at home and using dedicated e-ink e-readers was connected to less distractible reading engagement. Furthermore, reading behaviour was associated with location in text and timing within reading sessions: participants had a tendency to read the beginning of the text slower, and they were most likely to use nonlinear navigation and task-switch frequently at the beginning of a new reading session. Finally, the findings across the three studies showed that previous events could be used to predict variance in task-switching frequency, reading speed, and linearity, suggesting that a participants' behaviour on previous pages could be used to forecast future reading behaviour. Overall, the findings showcased that variance in reading behaviour is associated with the context in which the text is read.

In conclusion, this thesis presents novel findings on adults' natural e-reading behaviour. We used two new methodologies that can be used in future studies in support of existing research methods. Our findings on the connection between reading behaviour, reader characteristics, and task-contexts have the potential to inform future research, but also provide much needed insight into adults' natural reading engagement electronically that will be useful in development of reading interventions as well as spaces and devices that can support and encourage recreational reading engagement.

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Appendix A

Questionnaires

Intrinsic Motivation Inventory on Reading (IMI-R)

IMI-R was developed by Frijters (2004) to measure contextual reading motivation in children. It is based on the Intrinsic Motivation Inventory by Deci and Ryan (1990). We used IMI-R in all three studies reported in this thesis. The items were modified to allow use with adults, see Chapter 3: Surveys on Motivation for more detail.

The questionnaire:

Q1-20. Please indicate how true each of the following statements is for you, using the scale: 1 (Not at all true for me) to 7 (Very true for me).

- I think that recreational reading is boring[1,R]
- I think recreational reading is enjoyable[1]
- I am skilled at reading[2]
- I like recreational reading[1]
- I put a lot of effort into recreational reading[3]
- After reading for a while, I feel skilled[2]
- I read recreationally for the fun of it[1]
- I think I am good at reading[2]
- While I am reading recreationally, I think about how much I enjoy it[1]
- I am satisfied with how well I can read[2]
- I put energy into recreational reading[3]
- If I could choose what to do right now, I would read recreationally[1]
- I try hard when I read recreationally[3]
- I would describe recreational reading as interesting[1]
- I try hard to read well[3]
- It is important to me to do well at reading[3]
- Overall, I enjoy recreational reading[1]
- Reading is an activity that I can do well[2]
- Recreational reading is fun to do[1]

- I think I read well, in comparison to others[2]

[1]'Interest' subcomponent of IMI-R, used to represent extent of autonomous contextual motivation.

[2]'Competence' subcomponent of IMI-R, which reflects perceived reading skill.

[3]'Effort/Importance' subcomponent that was included in the questionnaire but not used in the studies.

[R] Reversed question.

The superscript indicators were not included in the questionnaire, shown for reference only.

Intrinsic Motivation Inventory (IMI)

The intrinsic motivation inventory was developed by Deci and Ryan (1990). It is a situational motivation measure that we used in the first and second studies reported in Chapters 4 and 5. The original items were modified for use in the studies by specifying the activity as 'reading the story'. At the beginning of the questionnaire in the second study (see Chapter 5), we specified that "'Story' refers to the book or novella that you selected from the Sirius E-reader library".

The questionnaire:

Q1-27: Please indicate how true each of the following statements is for you, using the scale: 1 (Not at all true for me) to 7 (Very true for me).

- While I was reading the story, I was thinking about how much I enjoyed it[1]
- Reading this story was an activity that I couldn't do very well[2,R]
- I read the story because I had to[3,R]
- Reading the story was a boring activity[1,R]
- I was anxious while reading the story[4]
- It was important to me to do well at reading the story[5]
- I would describe reading this story as very interesting[1]
- I was pretty skilled at reading the story[2]
- I felt like it was not my own choice to read the story[3,R]
- I didn't put much energy into reading the story[5,R]
- I thought that reading this story was quite enjoyable[1]

- I think I read the story pretty well, compared to others[2]
- I read the story because I had no choice[3,R]
- I read the story because I wanted to[3]
- Reading the story was fun to do[1]
- I think I am pretty good at reading stories[2]
- I put a lot of effort into reading the story[5]
- I felt pressured while reading the story[4]
- Reading the story did not hold my attention at all[1,R]
- I felt like I had to read the story[3,R]
- I enjoyed reading the story[1]
- I didn’t try very hard to read the story well[5,R]
- I didn’t really have a choice about reading the story[3,R]
- I tried very hard to read the story[5]
- I believe I had some choice about reading the story[3]
- I am satisfied with my performance at reading this story[2]
- After working on reading this story for a while, I felt pretty competent[2]

[1] ‘Interest’ subcomponent in the IMI, used to represent the extent of autonomous situational motivation.

[2] ‘Competence’ subcomponent in the IMI, which reflects perceived text difficulty.

[3] ‘Autonomy/Choice’ subcomponent in the IMI, which reflects perceived autonomy in text selection

[4] ‘Pressure’ subcomponent in the IMI that was included in the questionnaire but not used in the studies.

[5] ‘Effort/Importance’ subcomponent in the IMI that was included in the questionnaire but not used in the studies.

[R] Reversed question.

The superscript indicators were not included in the questionnaire, shown for reference only.

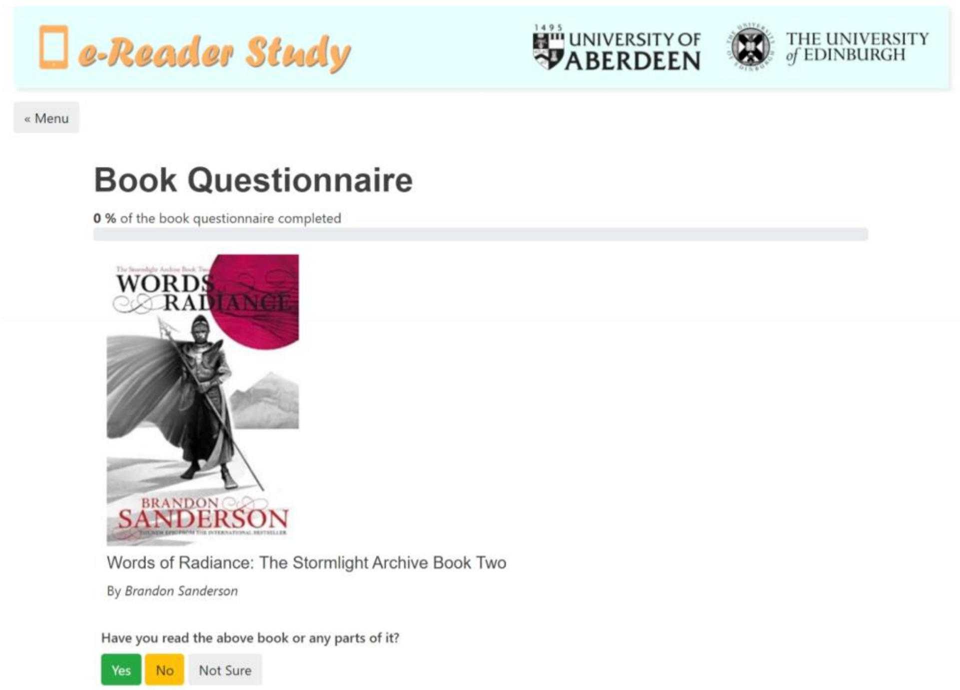
Book Questionnaire Used in Chapter 6

In Chapter 6, participants' situational motivation was assessed with a custom questionnaire instead of IMI. This is because we aimed to collect information on multiple different texts that were read on Amazon Kindle devices and applications, and using IMI would have overburdened the participants. This 'book questionnaire' was automatically generated for the 20 books that participants spent the most time reading.

Participants were first shown the cover, title and author of a book and asked if they remembered reading the book (see Figure A1).

Figure A1

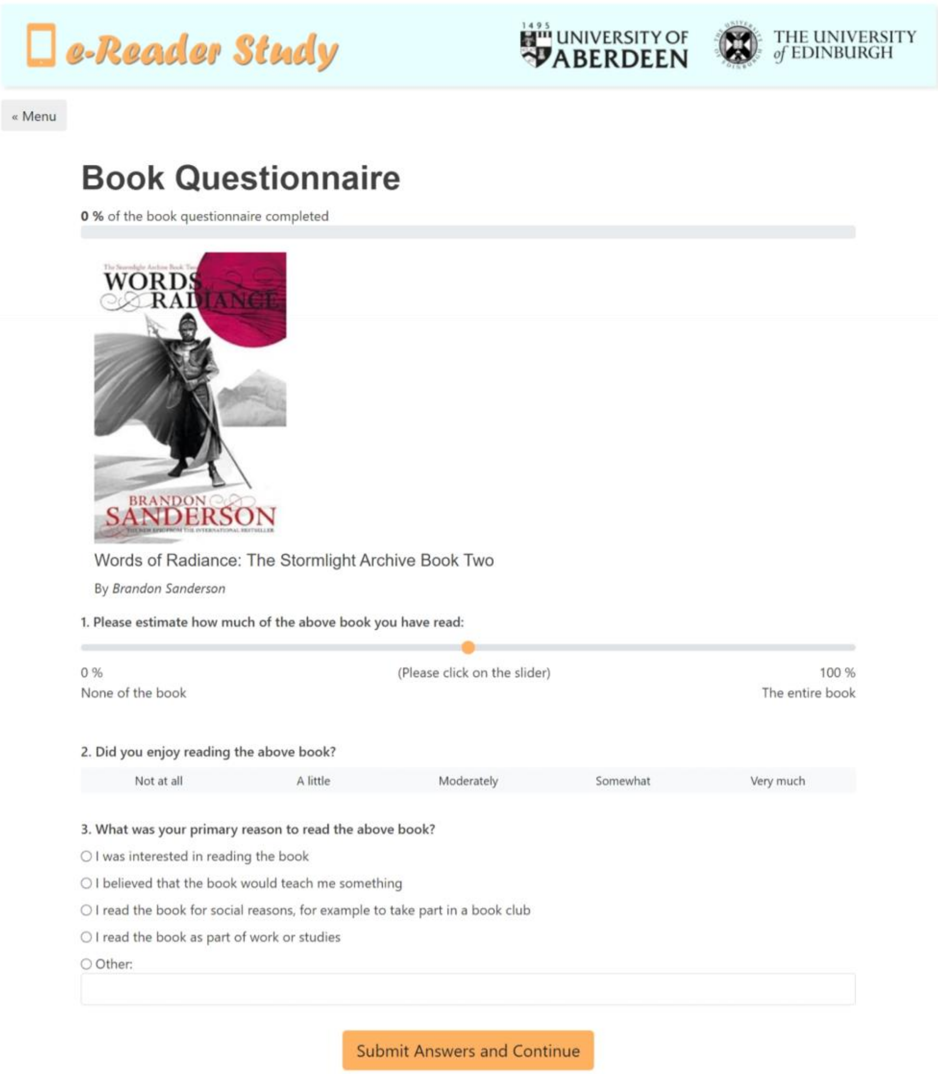
First Section of the Book Questionnaire.



If the participants indicated that they remembered reading the shown book, they were asked to respond to the items shown in Figure A2.

Figure A2

The Second Section of the Book Questionnaire.



If the participants reported that they do not remember reading a shown book, the next title was presented. Participants responded fully to a maximum of 20 books that they had spent the most time reading, and they were presented with a maximum of 30 books.

Questionnaire on Electronic Reading Experience

Q1. Which of the following devices do you own? Select all that apply

- Dedicated e-reader with an e-ink screen (such as Kindle Paperwhite, Kobo, or Nook)
- Desktop computer
- Laptop
- Smartphone

- Tablet computer (such as iPad)
- Other device with internet access such as a smartwatch or an iPod

Q2-22. Rate how frequently you engage in the following reading activities:

- How often do you read academic journals or conference articles electronically?
- How often do you read nonfiction books electronically?
- How often do you read fiction books electronically?[TT]
- How often do you read graphic novels electronically?
- How often do you read magazine, newspaper or other articles electronically?
- How often do you read short stories or fanfiction electronically? [TT]
- How often do you read textbooks electronically?
- How often do you use a dedicated e-reader with an e-ink screen (such as Kindle Paperwhite, Kobo or Nook) for reading recreationally?[DD3]
- How often do you use a desktop computer for reading recreationally?[DD1,DD2,DD3]
- How often do you use a laptop for reading recreationally?[DD1,DD2,DD3]
- How often do you use a smartphone for reading recreationally?[DD1,DD2,DD3]
- How often do you use a tablet computer (such as an iPad) for reading recreationally?[DD1,DD2,DD3]
- How often do you use a small device with internet access such as a smartwatch or an iPod for reading recreationally?
- How often do you use physical print books (hardcover or paperback) for reading recreationally?
- How often do you use a dedicated e-reader with an e-ink screen (such as Kindle Paperwhite, Kobo or Nook) for reading as part of work or study?
- How often do you use a desktop computer for reading as part of work or study?
- How often do you use a laptop for reading as part of work or study?
- How often do you use a smartphone for reading as part of work or study?
- How often do you use a tablet computer (such as an iPad) for reading as part of work or study?
- How often do you use a small device with internet access such as a smartwatch or an iPod for reading as part of work or study?
- How often do you use physical print books (hardcover or paperback) for reading as part of work or study?

[TT] Summed together to create a measure of task-relevant text types.

[DD1]Summed together to create a measure of task-relevant digital devices for the first study reported in Chapter 4.

[DD2]Summed together to create a measure of task-relevant digital devices for the second study reported in Chapter 5.

[DD3] Summed together to create a measure of task-relevant digital devices for the third study reported in Chapter 6.

Changes Done for the Second Study Described in Chapter 5

Questions 2-22 were included in the questionnaire as described above, however, Q1 was replaced with two new items:

1. Which reading formats do you prefer for reading books? Select all that apply.

- Printed books such as hardcovers or paperbacks
- Ebooks (electronic books)
- Audiobooks
- Other
- I don’t read books

2. Which of the following devices do you own or have regular access to? Select all that apply.

- Dedicated e-reader with an e-ink screen (such as Kindle Paperwhite, Kobo, or Nook)
- Desktop computer
- Laptop
- Smartphone
- Tablet computer (such as iPad)
- Other device with internet access such as a smartwatch or an iPod

Changes Done for the Third Study Described in Chapter 6

In question 1, participants were asked ‘Which of the following devices do you own or have regular access to? Select all that apply’ and the option for ‘Tablet computer’ was supplemented with ‘such as iPad or a Kindle Fire device’. These changes were done to encourage participants to report on the devices that they share with others.

Two questions were added to the questionnaire after the first question to gather more information on how participants use Amazon Kindle devices and applications.

1. Which of the following Amazon Kindle devices/applications have you used for reading? Select all that apply.

- Dedicated Kindle e-reader with an e-ink screen (such as Kindle Paperwhite)
- Kindle Fire device (Kindle device with an LCD-screen)
- Kindle smartphone app for android
- Kindle smartphone app for iOS
- Other Kindle smartphone app
- Kindle for PC or Mac (downloadable software)
- Kindle Cloud (web browser e-reader)

2. Do you share access to Kindle devices or applications with family or friends?

- Yes, someone else uses the same Kindle devices or applications with the same Amazon account.
- No, I am the only user of Kindle devices or applications on my Amazon account.
- Not sure

The original questionnaire on text types and digital devices (Q2-22 above) was shortened. We removed the last seven questions on frequency of using different devices for work or study reading purposes, and one item on frequency of using a small device such as a smartwatch or an iPod for recreational reading.

Following feedback from pilot participants, we added the following clarifications in the questionnaire:

- 'Recreational reading refers to any voluntary reading for leisure' was added to all questionnaires on frequency of using different digital devices for recreational reading.
- 'Any electronic applications or devices' was added to all questions on frequency of reading different text types for reading electronically.

Author Recognition Test (ART)

ART is a print exposure measure that was used in Chapter 5. The original version was developed by Stanovich (1986). We used a version of ART developed by Fong et al. (2013) and Mar and Rain (2015). In the test, participants were shown a list of author names and they were asked to check the box next to each name that they recognised. Participants were not shown with any other information on the authors, but for reference purposes we show additional information as well.

Table A1

Author Recognition Test Used in Chapter 5.

Author Name	Genre	Real Author Name?
Alice Munro	Literary	✓
Frank Herbert	Sci-Fi/Fantasy	✓
Paulo Coelho	Translated literary	✓
Emily Giffin	Romance	✓
Jo Davis	Romance	✓
Milan Kundera	Translated literary	✓
Alice Sebold	Literary	✓
Orson Scott Card	Sci-Fi/Fantasy	✓
Terry Brooks	Sci-Fi/Fantasy	✓
Carol Shields	Literary	✓
Arthur C. Clarke	Sci-Fi/Fantasy	✓
Iris Johansen	Romance	✓
John Grisham	Suspense	✓
Amy Tan	Literary	✓
Donna Leon	Suspense	✓
Mary Higgins Clark	Suspense	✓
Fern Michaels	Romance	✓
Larry Niven	Sci-Fi/Fantasy	✓
Julia London	Romance	✓
Michael Connelly	Suspense	✓
John Updike	Literary	✓
Jackie Collins	Romance	✓
Ken Follett	Suspense	✓
P. D. James	Suspense	✓
Chuck Palahniuk	Literary	✓
Jonathan Kellerman	Suspense	✓

Jayne Ann Krentz	Romance	✓
Umberto Eco	Translated literary	✓
Nora Roberts	Romance	✓
Robert Jordan	Sci-Fi/Fantasy	✓
Terry Goodkind	Sci-Fi/Fantasy	✓
Christopher Moore	Literary	✓
Douglas Adams	Sci-Fi/Fantasy	✓
Dick Francis	Suspense	✓
Joy Fielding	Romance	✓
Wally Lamb	Literary	✓
Jacqueline Carey	Sci-Fi/Fantasy	✓
Nicholas Sparks	Romance	✓
Ursula K. Le Guin	Sci-Fi/Fantasy	✓
Margaret Weis	Sci-Fi/Fantasy	✓
Gabriel Garcia Marquez	Translated literary	✓
Lisa Kleypas	Romance	✓
Clive Cussler	Suspense	✓
Audrey Niffeneger	Romance	✓
Douglas Coupland	Literary	✓
Neil Gaiman	Sci-Fi/Fantasy	✓
Maeve Binchy	Romance	✓
Anne McCaffrey	Sci-Fi/Fantasy	✓
Gregory Maguire	Sci-Fi/Fantasy	✓
Yukio Mishima	Translated literary	✓
Tom Robbins	Literary	✓
Diana Palmer	Romance	✓
Jude Deveraux	Romance	✓
Alastair Reynolds	Sci-Fi/Fantasy	✓
Danielle Steele	Romance	✓
J. D. Salinger	Literary	✓
William Faulkner	Literary	✓

Judith Krantz	Romance	✓
Sue Grafton	Suspense	✓
Kim Harrison	Sci-Fi/Fantasy	✓
Jodi Picoult	Literary	✓
Diana Gabaldon	Romance	✓
James Patterson	Suspense	✓
Jack Higgins	Suspense	✓
Meg Cabot	Romance	✓
John Irving	Literary	✓
Greg Bear	Sci-Fi/Fantasy	✓
Charlaine Harris	Romance	✓
Philip K. Dick	Sci-Fi/Fantasy	✓
Karen Marie Moning	Romance	✓
Harlan Coben	Suspense	✓
John Steinbeck	Literary	✓
Italo Calvino	Translated literary	✓
Vince Flynn	Suspense	✓
Joseph Heller	Literary	✓
Robert Ludlum	Suspense	✓
Albert Camus	Translated literary	✓
Philippa Gregory	Literary	✓
Robert A. Heinlein	Sci-Fi/Fantasy	✓
Ian Rankin	Suspense	✓
Sandra Brown	Romance	✓
R. A. Salvatore	Sci-Fi/Fantasy	✓
John LeCarré	Suspense	✓
Sherrilyn Kenyon	Romance	✓
José Saramago	Translated literary	✓
Jeffrey Deaver	Suspense	✓
George R. R Martin	Sci-Fi/Fantasy	✓
Rohinton Mistry	Translated literary	✓

Patricia Cornwell	Suspense	✓
John Saul	Suspense	✓
Terry Pratchett	Sci-Fi/Fantasy	✓
Sidney Sheldon	Romance	✓
Thomas Mann	Translated literary	✓
Sinclair Ross	Literary	✓
Jim Butcher	Sci-Fi/Fantasy	✓
Toni Morrison	Literary	✓
Michael Jecks	Suspense	✓
Timothy Findley	Literary	✓
W. G. Sebald	Translated literary	✓
Dean Koontz	Suspense	✓
Robert B. Parker	Suspense	✓
Sophie Kinsella	Romance	✓
Piers Anthony	Sci-Fi/Fantasy	✓
Catherine Anderson	Romance	✓
W. O. Mitchell	Literary	✓
Ray Bradbury	Sci-Fi/Fantasy	✓
Yann Martel	Literary	✓
William Gibson	Sci-Fi/Fantasy	✓
Cathy Reichs	Suspense	✓
Nelson DeMille	Suspense	✓
Aimee Emery		
Alister Yussen		
Carl Daniels		
Dale Blass		
David Passman		
Denise Cuneo		
Diane Corter		
Edward Condry		
Elliot Bever		
Eric Adamson		

Frances Gresham

Frank Bluth

Frank Killarney

Franklin D. Manis

Gary Baron

Geraldine Dickson

Harold Gallivan

Hilda Blyth

Hugh Liben

James Mendelson

Jonathan T. Cortes

K. Warner Sexton

Lauren Amsel

Lynn H. Larson

Margaritia Barrera

Mark Sorenson

Martin Faulkner

Miriam Schaie

Morton Lytton

Oscar Asmitia

Reed Inness

Reuben Beauchamp

Richard Plath

Robert Donahue

Robert Irons

Robert Saul

Scott Parson

Steve Yorel

Thomas Borko

W. Patrick Dawson

Note. Participants were only shown the author names.

Additional Items

Pre-experimental Items

At the beginning of the study, we asked to participants to respond to items on demographic information and their general reading habits and preferences. To capture demographic information, we asked participants to report their age, gender, whether English was their native language, and what is the highest level of education they have attained. Participants were then asked how often they read for pleasure and for work or study on a 5-point Likert-scale from *Never* to *Every day*.

Information on book preferences was captured with the following question that was obtained from the Reading Outcomes Framework Toolkit by The Reading Agency (2016):

What types of genres of books do you find most enjoyable? Select all that apply.

- Biographies/autobiographies
- Celebrities/television
- Classic novels
- Crime, thrillers, and mystery
- Fantasy
- Graphic novels
- Historical fiction
- History
- Horror
- Humour
- Modern fiction
- Poetry
- Politics/current affairs
- Religion/spirituality
- Romance
- Science
- Science fiction
- Self-help
- Special interests/hobbies

- Sports
- Travel

Furthermore, we asked directly about participants' primary reasons for reading:

What is your primary reason for reading?

- To improve health and well being - for example, to relax, to fall asleep, or to improve mental health.
- Intellectual improvement - for example, to gain knowledge, or to learn a language.
- Personal development - for example, to increase creativiness, self-esteem or empathy.
- Social reasons - for example, to take part in cultural activities or to enhance understanding of others.
- Enjoyment - for example, because you enjoy reading, like books, or it makes you happy.
- Boredom - for example, to avoid boredom or to pass time.
- I only read if I have to.
- I do not read.
- Other, please comment below.

Changes for Individual Studies

The studies differed slightly in what additional items were included. In Chapters 4 and 6, we asked participants to report on their reading amount with the following item:

How many books did you read for pleasure during the last year (2019/2021 - depending on the study)?

- None
- 1-2 books
- 3-6 books
- 7-15 books
- 16-25 books
- 26-50 books
- More than 50 books

Whereas the item was judged to be useful for Chapters 4 and 6 of which recruitment began at the beginning of a new year, the item was not included in the study reported in

Chapter 5 because the study recruitment began in the middle of a year, and so participants were expected to struggle to remember their reading amount.

Data for the study reported in Chapter 5 was collected from 31st August 2021 to 27th June 2022. Therefore, the study period overlapped the COVID-19 pandemic. To capture how participants were influenced by the pandemic, we added the following items in the questionnaire:

How would you describe the current state of the COVID-19 pandemic in your location? Response scale: Very poor / Somewhat poor / Moderate / Somewhat good / Very Good

Has COVID-19 influenced how much time you spend at home? Response scale: Yes, I spend more time at home / Yes, I spend less time at home / No, COVID-19 has not influenced how much time I spend at home / I don’t know

Has COVID-19 influenced how much spare time you have? Response scale: Yes, I have more spare time / Yes, I have less spare time / No, COVID-19 has not influenced how much spare time I have / I don’t know

Has the COVID-19 pandemic had any influence on how you read or how often you read? Response scale: Yes / No / I don’t know

If you answered yes to the previous question, please describe how COVID-19 has changed your reading. (Open text response).

In Chapter 6, on the other hand, we were interested in participants’ multiple text reading habits. To capture this, we used the following items:

Please indicate how true each of the following statements is for you, using the scale: 1 (Not at all true for me) to 7 (Very true for me)

- I am often in the middle of reading multiple different books.
- I wouldn’t start a new book if I’m in the middle of reading another one.
- I usually alternate between reading books electronically and reading physical print books.

Post-experimental Items

Items were also added to the questionnaires responded to after the reading phase. In studies described in Chapters 4 and 5, we asked participants directly about their enjoyment of the text:

Did you enjoy reading the story? Response scale: Not at all / A little / Moderately / Somewhat / Very much Additional response option used in Chapter 5: I did not read the story.

Similarly to the pre-experimental stage, we asked participants directly about their motivations for reading the text during the study:

What was your primary reason for reading the story?

- To improve health and well being - for example, to relax, to fall asleep, or to improve mental health.
- Intellectual improvement - for example, to gain knowledge, or to learn a language.
- Personal development - for example, to increase creativiness, self-esteem or empathy.
- Social reasons - for example, to take part in cultural activities or to enhance understanding of others.
- Enjoyment - for example, because you enjoy reading, like books, or it makes you happy.
- Boredom - for example, to avoid boredom or to pass time.
- I only read if I have to.
- I do not read.
- Other, please comment below.

Additionally in Chapter 4, we included the option “Getting payment for completing the study” which was reflected in the option “Receiving the infographic on my own reading behaviour” in Chapter 5.

Furthermore, participants were asked about their reading progress and whether they had any feedback on the e-reader system using the following items:

Have you previously read the story? Response scale: No, this was my first time reading this story / Yes, I have read this story before / Not sure

How far did you read in the story? Response scale: A freely moved slider that allowed participants to choose their reading time in one minute increments from '0h' to '20h+'.

Did you have any issues in using the e-reader or did you encounter any problems? Response scale: No / Yes, please explain: (Open text response)

If you have any comments or suggestions, please feel free to leave them below: Response scale: Open text response.

Finally, participants were asked to write a short summary for the story they read in the study by using an open text response field.

Appendix B

Consent Forms, Information Sheets, and Debrief Sheets Used in the Studies

Across the three studies, all participants provided informed consent. Before responding the consent form, participants were asked to read through an information sheet explaining what the study involves. At the end of the study, participants were shown a debrief sheet which was sent in their email for their records.

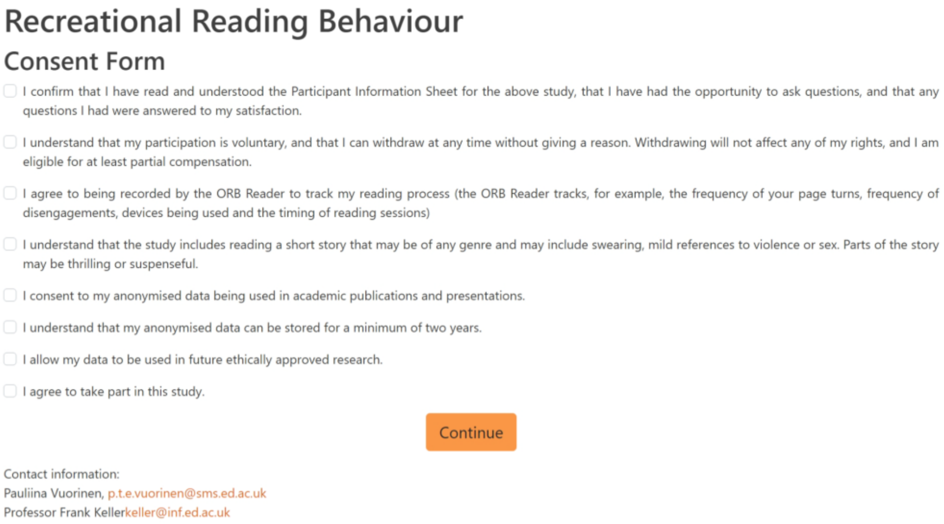
As the studies varied, so did the consent forms, information sheets, and debrief sheets used. Below, we include the documents used in each of the studies. All documents were reviewed and approved by the Ethical Committee in School of Informatics, University of Edinburgh (reference: 2019/81073).

Chapter 4: Study on Short Story Reading Behaviour

The e-reader system was called 'ORB Reader' (= Objective Reading Behaviour) during data collection.

Figure B1

Consent Form as it was Shown in the E-reader System (Chapter 4).



Recreational Reading Behaviour

Consent Form

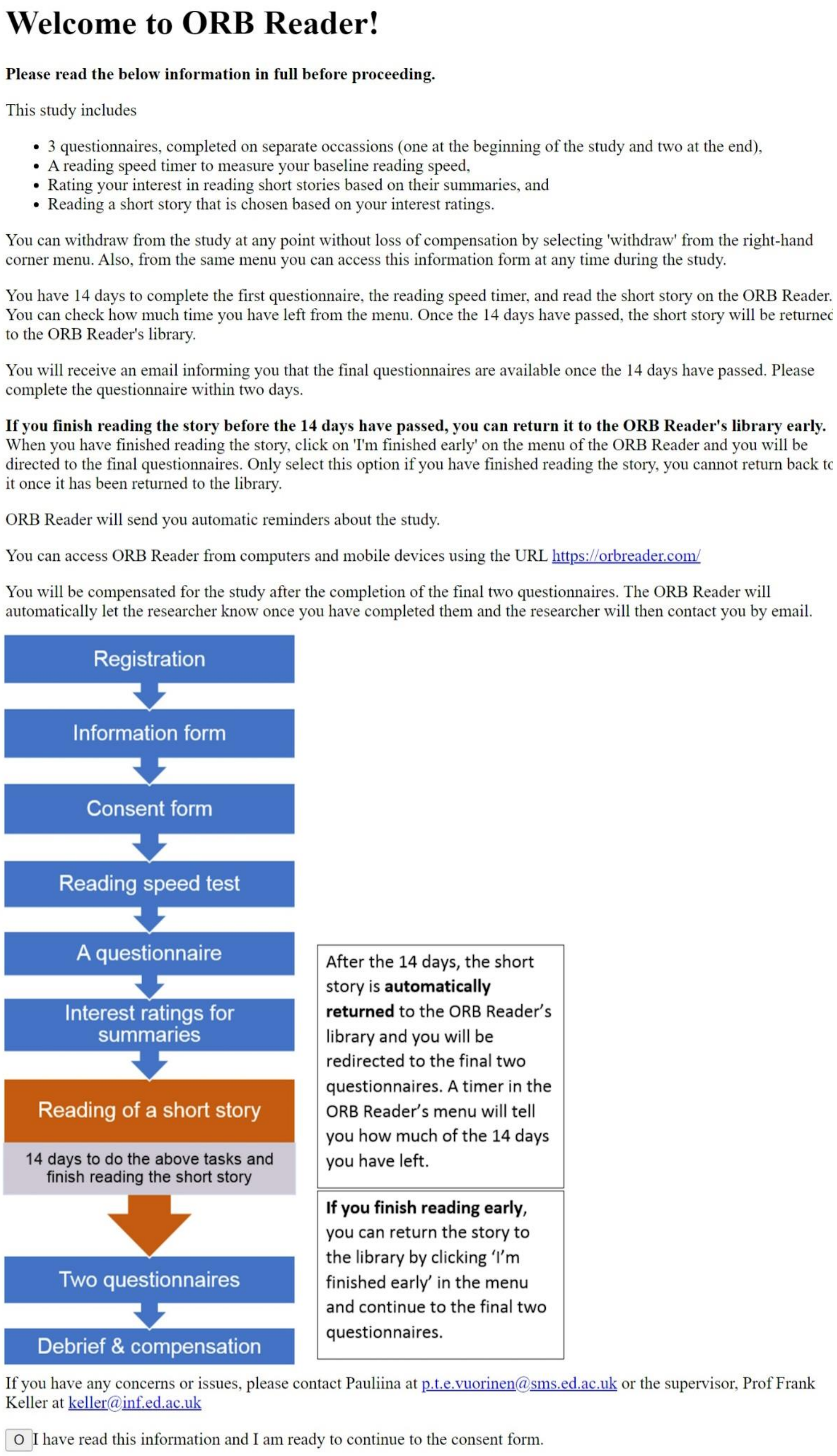
- [ ] I confirm that I have read and understood the Participant Information Sheet for the above study, that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.
- [ ] I understand that my participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights, and I am eligible for at least partial compensation.
- [ ] I agree to being recorded by the ORB Reader to track my reading process (the ORB Reader tracks, for example, the frequency of your page turns, frequency of disengagements, devices being used and the timing of reading sessions)
- [ ] I understand that the study includes reading a short story that may be of any genre and may include swearing, mild references to violence or sex. Parts of the story may be thrilling or suspenseful.
- [ ] I consent to my anonymised data being used in academic publications and presentations.
- [ ] I understand that my anonymised data can be stored for a minimum of two years.
- [ ] I allow my data to be used in future ethically approved research.
- [ ] I agree to take part in this study.

Continue

Contact information:
Pauliina Vuorinen, p.t.e.vuorinen@sms.ed.ac.uk
Professor Frank Kellerkeller@inf.ed.ac.uk

Figure B2

Information Sheet as it was Shown in E-reader system (Chapter 4)



Welcome to ORB Reader!

Please read the below information in full before proceeding.

This study includes

- 3 questionnaires, completed on separate occassions (one at the beginning of the study and two at the end),
- A reading speed timer to measure your baseline reading speed,
- Rating your interest in reading short stories based on their summaries, and
- Reading a short story that is chosen based on your interest ratings.

You can withdraw from the study at any point without loss of compensation by selecting 'withdraw' from the right-hand corner menu. Also, from the same menu you can access this information form at any time during the study.

You have 14 days to complete the first questionnaire, the reading speed timer, and read the short story on the ORB Reader. You can check how much time you have left from the menu. Once the 14 days have passed, the short story will be returnec to the ORB Reader's library.

You will receive an email informing you that the final questionnaires are available once the 14 days have passed. Please complete the questionnaire within two days.

If you finish reading the story before the 14 days have passed, you can return it to the ORB Reader's library early. When you have finished reading the story, click on 'I'm finished early' on the menu of the ORB Reader and you will be directed to the final questionnaires. Only select this option if you have finished reading the story, you cannot return back tc it once it has been returned to the library.

ORB Reader will send you automatic reminders about the study.

You can access ORB Reader from computers and mobile devices using the URL https://orbreader.com/

You will be compensated for the study after the completion of the final two questionnaires. The ORB Reader will automatically let the researcher know once you have completed them and the researcher will then contact you by email.

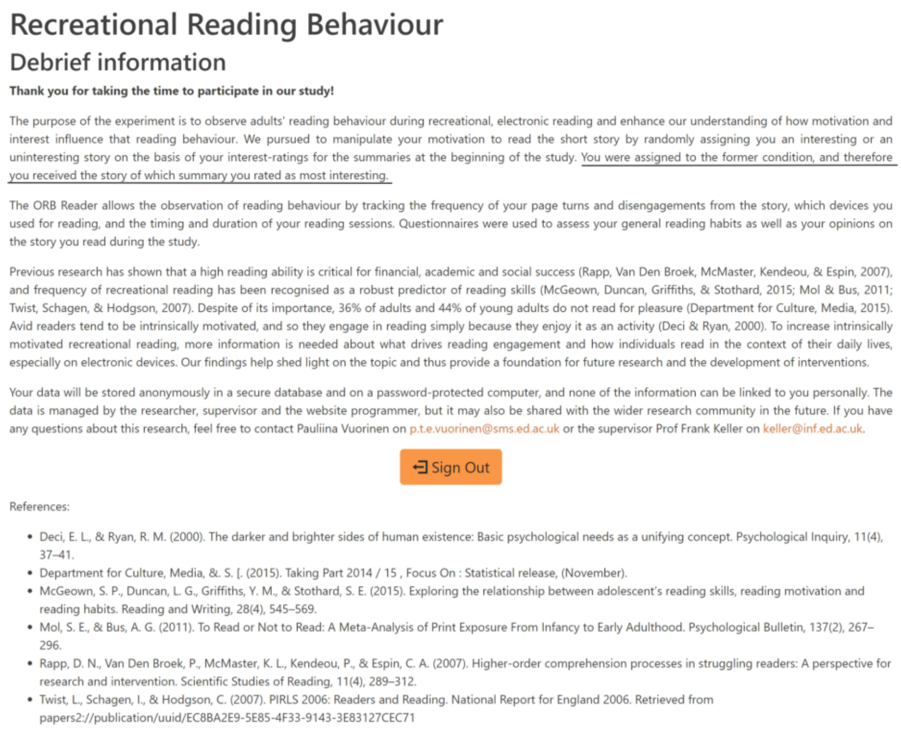
If you have any concerns or issues, please contact Pauliina at p.t.e.vuorinen@sms.ed.ac.uk or the supervisor, Prof Frank Keller at keller@inf.ed.ac.uk

O I have read this information and I am ready to continue to the consent form.

Note. For a full resolution version, see https://pauliinav.github.io/Natural_e-Reading_Behaviour_Materials/Appendices/AppB_InfoSheetCh4.jpg

Figure B3

Debrief Sheet as it was Shown in the E-reader System (Chapter 4)



Recreational Reading Behaviour

Debrief information

Thank you for taking the time to participate in our study!

The purpose of the experiment is to observe adults' reading behaviour during recreational, electronic reading and enhance our understanding of how motivation and interest influence that reading behaviour. We pursued to manipulate your motivation to read the short story by randomly assigning you an interesting or an uninteresting story on the basis of your interest-ratings for the summaries at the beginning of the study. You were assigned to the former condition, and therefore you received the story of which summary you rated as most interesting.

The ORB Reader allows the observation of reading behaviour by tracking the frequency of your page turns and disengagements from the story, which devices you used for reading, and the timing and duration of your reading sessions. Questionnaires were used to assess your general reading habits as well as your opinions on the story you read during the study.

Previous research has shown that a high reading ability is critical for financial, academic and social success (Rapp, Van Den Broek, McMaster, Kendeou, & Espin, 2007), and frequency of recreational reading has been recognised as a robust predictor of reading skills (McGeown, Duncan, Griffiths, & Stothard, 2015; Mol & Bus, 2011; Twist, Schagen, & Hodgson, 2007). Despite of its importance, 36% of adults and 44% of young adults do not read for pleasure (Department for Culture, Media, 2015). Avid readers tend to be intrinsically motivated, and so they engage in reading simply because they enjoy it as an activity (Deci & Ryan, 2000). To increase intrinsically motivated recreational reading, more information is needed about what drives reading engagement and how individuals read in the context of their daily lives, especially on electronic devices. Our findings help shed light on the topic and thus provide a foundation for future research and the development of interventions.

Your data will be stored anonymously in a secure database and on a password-protected computer, and none of the information can be linked to you personally. The data is managed by the researcher, supervisor and the website programmer, but it may also be shared with the wider research community in the future. If you have any questions about this research, feel free to contact Pauliina Vuorinen on p.t.e.vuorinen@sms.ed.ac.uk or the supervisor Prof Frank Keller on keller@inf.ed.ac.uk.

Sign Out

References:

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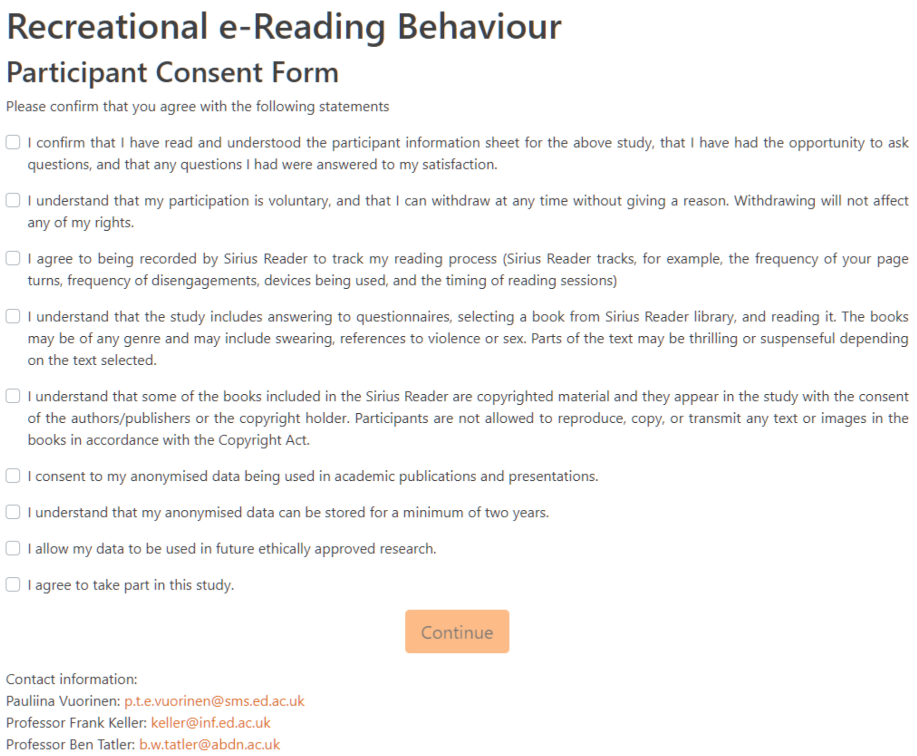
Note. The underlined section of the debrief was varied based on the participant's autonomy condition. Whereas participants in the high-autonomy condition were shown the text in the image, this section was replaced with *"You were assigned to the latter condition, and therefore you received the story of which summary you rated as the least interesting"* for participants in the low-autonomy condition.

Chapter 5: Study on Book Reading Behaviour

In Chapter 5, the e-reader system was called 'Sirius Reader'. The e-reader system was given a name so that it would be easier for the participants to remember, and the names were changed between studies so that a new website domain could be used.

Figure B4

Consent Form as it was Shown in the E-reader System (Chapter 5).



Recreational e-Reading Behaviour

Participant Consent Form

Please confirm that you agree with the following statements

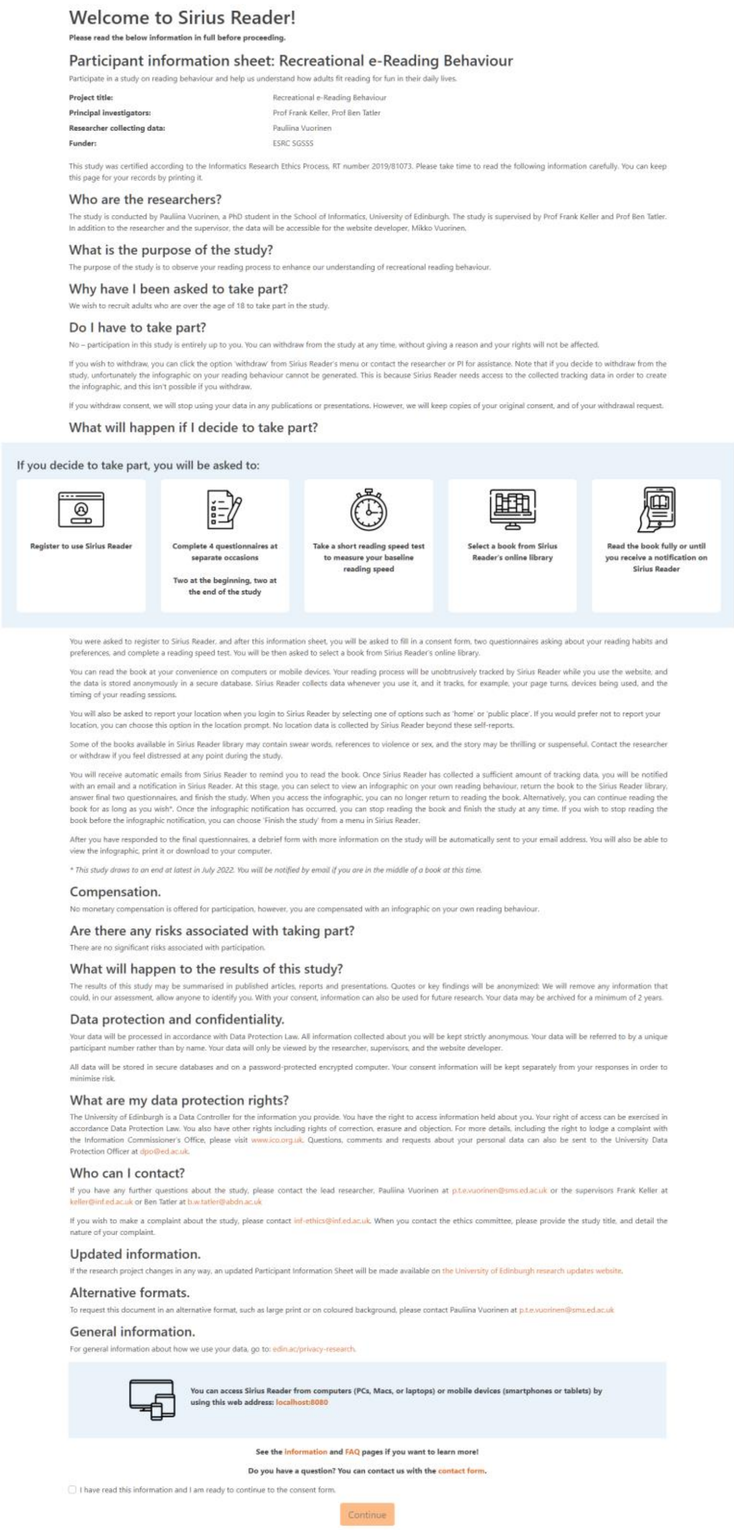
- [ ] I confirm that I have read and understood the participant information sheet for the above study, that I have had the opportunity to ask questions, and that any questions I had were answered to my satisfaction.
- [ ] I understand that my participation is voluntary, and that I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights.
- [ ] I agree to being recorded by Sirius Reader to track my reading process (Sirius Reader tracks, for example, the frequency of your page turns, frequency of disengagements, devices being used, and the timing of reading sessions)
- [ ] I understand that the study includes answering to questionnaires, selecting a book from Sirius Reader library, and reading it. The books may be of any genre and may include swearing, references to violence or sex. Parts of the text may be thrilling or suspenseful depending on the text selected.
- [ ] I understand that some of the books included in the Sirius Reader are copyrighted material and they appear in the study with the consent of the authors/publishers or the copyright holder. Participants are not allowed to reproduce, copy, or transmit any text or images in the books in accordance with the Copyright Act.
- [ ] I consent to my anonymised data being used in academic publications and presentations.
- [ ] I understand that my anonymised data can be stored for a minimum of two years.
- [ ] I allow my data to be used in future ethically approved research.
- [ ] I agree to take part in this study.

Continue

Contact information:
Pauliina Vuorinen: p.t.e.vuorinen@sms.ed.ac.uk
Professor Frank Keller: keller@inf.ed.ac.uk
Professor Ben Tatler: b.w.tatler@abdn.ac.uk

Figure B5

Information sheet as it was Shown in the E-reader System (Chapter 5).



Welcome to Sirius Reader!

Please read the below information in full before proceeding.

Participant information sheet: Recreational e-Reading Behaviour

Participate in a study on reading behaviour and help us understand how adults fit reading for fun in their daily lives.

Project title:	Recreational e-Reading Behaviour
Principal investigators:	Prof Frank Keller, Prof Ben Tatler
Researcher collecting data:	Pauliina Vuorinen
Funder:	ESRC SGSSS

This study was certified according to the Informatics Research Ethics Process, RT number 2019/81073. Please take time to read the following information carefully. You can keep this page for your records by printing it.

Who are the researchers?

The study is conducted by Pauliina Vuorinen, a PhD student in the School of Informatics, University of Edinburgh. The study is supervised by Prof Frank Keller and Prof Ben Tatler. In addition to the researcher and the supervisor, the data will be accessible for the website developer, Mikko Vuorinen.

What is the purpose of the study?

The purpose of the study is to observe your reading process to enhance our understanding of recreational reading behaviour.

Why have I been asked to take part?

We wish to recruit adults who are over the age of 18 to take part in the study.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason and your rights will not be affected.

If you wish to withdraw, you can click the option 'withdraw' from Sirius Reader's menu or contact the researcher or PI for assistance. Note that if you decide to withdraw from the study, unfortunately the infographic on your reading behaviour cannot be generated. This is because Sirius Reader needs access to the collected tracking data in order to create the infographic, and this isn't possible if you withdraw.

If you withdraw consent, we will stop using your data in any publications or presentations. However, we will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

If you decide to take part, you will be asked to:

- **Register to use Sirius Reader**
- **Complete 4 questionnaires at separate occasions** — **Two at the beginning, two at the end of the study**
- **Take a short reading speed test to measure your baseline reading speed**
- **Select a book from Sirius Reader's online library**
- **Read the book fully or until you receive a notification on Sirius Reader**

You were asked to register to Sirius Reader, and after this information sheet, you will be asked to fill in a consent form, two questionnaires asking about your reading habits and preferences, and complete a reading speed test. You will be then asked to select a book from Sirius Reader's online library.

You can read the book at your convenience on computers or mobile devices. Your reading process will be unobtrusively tracked by Sirius Reader while you use the website, and the data is stored anonymously in a secure database. Sirius Reader collects data whenever you use it, and it tracks, for example, your page turns, devices being used, and the timing of your reading sessions.

You will also be asked to report your location when you login to Sirius Reader by selecting one of options such as 'home' or 'public place'. If you would prefer not to report your location, you can choose this option in the location prompt. No location data is collected by Sirius Reader beyond these self-reports.

Some of the books available in Sirius Reader library may contain swear words, references to violence or sex, and the story may be thrilling or suspenseful. Contact the researcher or withdraw if you feel distressed at any point during the study.

You will receive automatic emails from Sirius Reader to remind you to read the book. Once Sirius Reader has collected a sufficient amount of tracking data, you will be notified with an email and a notification in Sirius Reader. At this stage, you can select to view an infographic on your own reading behaviour, return the book to the Sirius Reader library, answer final two questionnaires, and finish the study. When you access the infographic, you can no longer return to reading the book. Alternatively, you can continue reading the book for as long as you wish*. Once the infographic notification has occurred, you can stop reading the book and finish the study at any time. If you wish to stop reading the book before the infographic notification, you can choose 'Finish the study' from a menu in Sirius Reader.

After you have responded to the final questionnaires, a debrief form with more information on the study will be automatically sent to your email address. You will also be able to view the infographic, print it or download to your computer.

** This study draws to an end at latest in July 2022. You will be notified by email if you are in the middle of a book at this time.*

Compensation.

No monetary compensation is offered for participation, however, you are compensated with an infographic on your own reading behaviour.

Are there any risks associated with taking part?

There are no significant risks associated with participation.

What will happen to the results of this study?

The results of this study may be summarised in published articles, reports and presentations. Quotes or key findings will be anonymized: We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used for future research. Your data may be archived for a minimum of 2 years.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly anonymous. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the researcher, supervisors, and the website developer.

All data will be stored in secure databases and on a password-protected encrypted computer. Your consent information will be kept separately from your responses in order to minimise risk.

What are my data protection rights?

The University of Edinburgh is a Data Controller for the information you provide. You have the right to access information held about you. Your right of access can be exercised in accordance Data Protection Law. You also have other rights including rights of correction, erasure and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the lead researcher, Pauliina Vuorinen at p.t.e.vuorinen@sms.ed.ac.uk or the supervisors Frank Keller at keller@inf.ed.ac.uk or Ben Tatler at b.w.tatler@abdn.ac.uk

If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact the ethics committee, please provide the study title, and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be made available on the University of Edinburgh research updates website.

Alternative formats.

To request this document in an alternative format, such as large print or on coloured background, please contact Pauliina Vuorinen at p.t.e.vuorinen@sms.ed.ac.uk

General information.

For general information about how we use your data, go to: edin.ac/privacy-research.

You can access Sirius Reader from computers (PCs, Macs, or laptops) or mobile devices (smartphones or tablets) by using this web address: localhost:8080

See the information and FAQ pages if you want to learn more!

Do you have a question? You can contact us with the contact form.

☐ I have read this information and I am ready to continue to the consent form.

Continue

Note. For a full resolution version, see https://pauliinav.github.io/Natural_e-Reading_Behaviour_Materials/Appendices/AppB_InfoSheetCh5.png

Figure B6

Debrief sheet as it was Shown in the E-reader System (Chapter 5).

Recreational E-Reading Behaviour

Debrief information

Thank you for taking the time to participate in our study!

The purpose of the experiment is to observe adults' reading behaviour during recreational, electronic reading, and enhance our understanding of how motivation and interest influence that reading behaviour. We expect participants who are more interested in the book they read during the study to be more likely to continue reading it when they receive the infographic notification and are given the opportunity to finish the study. We also expect to see differences in participants overall reading behaviour, such as whether they read the book chronologically from beginning to end, and how often they get distracted during reading.

The Sirius Reader allows the observation of reading behaviour by tracking the frequency of your page turns and disengagements from the story, which devices you used for reading, and the timing and duration of your reading sessions. Questionnaires were used to assess your general reading habits as well as your opinions on the story you read during the study. We also tracked your engagement with the different books in Sirius Reader library in order to study if text selection behaviour (such as extensive exploration of available options) is related to motivation and reading behaviour.

Previous research has shown that a high reading ability is critical for financial, academic and social success (Rapp, Van Den Broek, McMaster, Kendeou, & Espin, 2007), and frequency of recreational reading has been recognised as a robust predictor of reading skills (McGeown, Duncan, Griffiths, & Stothard, 2015; Mol & Bus, 2011; Twist, Schagen, & Hodgson, 2007). Despite of its importance, 36% of adults and 44% of young adults do not read for pleasure (Department for Culture Media and Sport, 2015). Avid readers tend to be intrinsically motivated, and so they engage in reading simply because they enjoy it as an activity (Deci & Ryan, 2000). To increase intrinsically motivated recreational reading, more information is needed about what drives reading engagement and how individuals read in the context of their daily lives, especially on electronic devices. Our findings help shed light on the topic and thus provide a foundation for future research and the development of interventions.

Your data will be stored anonymously in a secure database and on a password-protected computer, and none of the information can be linked to you personally. The data is managed by the researcher, supervisor and the website programmer, but it may also be shared with the wider research community in the future. If you have any questions about this research, feel free to contact Pauliina Vuorinen on p.t.e.vuorinen@sms.ed.ac.uk or the primary supervisor Prof Frank Keller on keller@inf.ed.ac.uk.

Logout

References

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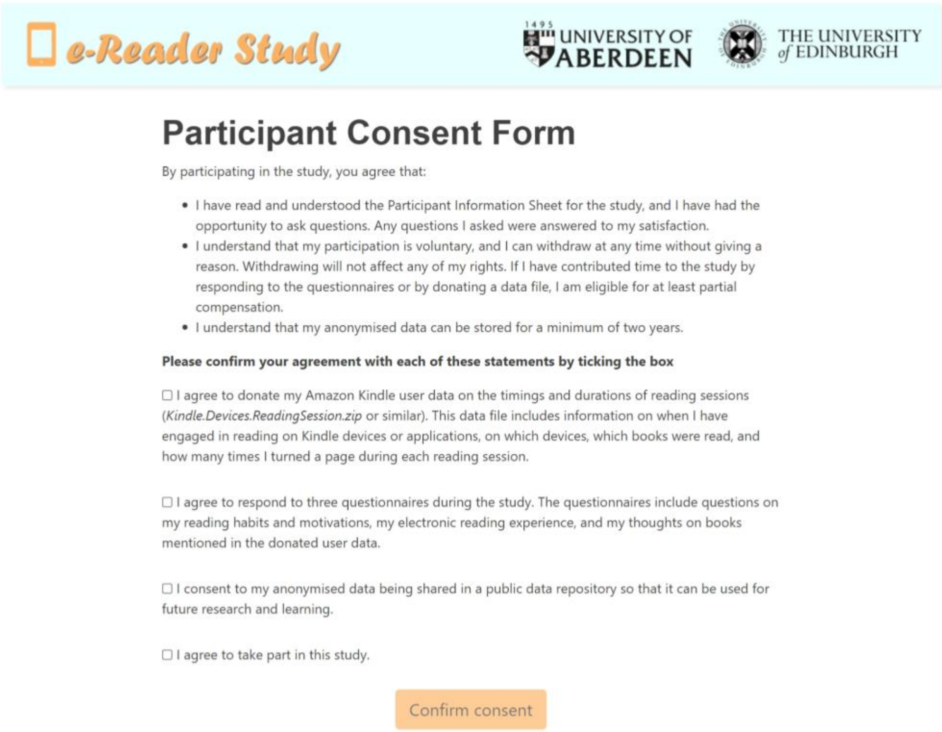
Chapter 6: Study on Reading Behaviour on Amazon Kindle Devices

Figure B7

Consent Form as it was Shown in the e-Reader Study Portal.



e-Reader Study

UNIVERSITY OF ABERDEEN

THE UNIVERSITY of EDINBURGH

Participant Consent Form

By participating in the study, you agree that:

- I have read and understood the Participant Information Sheet for the study, and I have had the opportunity to ask questions. Any questions I asked were answered to my satisfaction.
- I understand that my participation is voluntary, and I can withdraw at any time without giving a reason. Withdrawing will not affect any of my rights. If I have contributed time to the study by responding to the questionnaires or by donating a data file, I am eligible for at least partial compensation.
- I understand that my anonymised data can be stored for a minimum of two years.

Please confirm your agreement with each of these statements by ticking the box

☐ I agree to donate my Amazon Kindle user data on the timings and durations of reading sessions (*Kindle.Devices.ReadingSession.zip* or similar). This data file includes information on when I have engaged in reading on Kindle devices or applications, on which devices, which books were read, and how many times I turned a page during each reading session.

☐ I agree to respond to three questionnaires during the study. The questionnaires include questions on my reading habits and motivations, my electronic reading experience, and my thoughts on books mentioned in the donated user data.

☐ I consent to my anonymised data being shared in a public data repository so that it can be used for future research and learning.

☐ I agree to take part in this study.

Confirm consent

Figure B8

Information Sheet as it was Shown in the e-Reader Study Portal.

e-Reader Study

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Study Information

This study was certified according to the Informatics Research Ethics Process, RT number 2019/81073. Please read the following information carefully.

The study includes:

- Signing up for the study information emails
- Accessing a study data donation portal, and answering to three questionnaires on separate occasions (two at any point during the study, and one after donating a data file)
- Requesting your Amazon Kindle user data from Amazon UK
- Donating one anonymous file from the user data for research

Please note that this study is non-commercial and not affiliated with or endorsed by Amazon.

Who are the researchers?

The study is conducted by Pauliina Vuorinen, a PhD student in the School of Informatics, University of Edinburgh. The study is supervised by Prof Frank Keller and Prof Ben Tatler. In addition to the researcher and the supervisors, the data will be accessible for the website developer, Mikko Vuorinen.

What is the purpose of the study?

The purpose of the study is to collect information on your reading sessions to enhance our understanding of recreational reading behaviour. Our aim is to assess if motivation and electronic reading experience influence this behaviour.

Why have I been asked to take part?

We aim to recruit adults over the age of 18 to take part in the study. To be eligible to particate, you should use or have used Amazon Kindle devices (such as Kindle Paperwhite or Kindle Fire) or Amazon Kindle applications (such as Kindle on Android or Kindle for iPhone/iPad) for reading. You should also be currently located in the UK, and you should have access to an Amazon UK account linked to a Kindle device or a Kindle application.

Do I have to take part?

No – participation in this study is entirely up to you. You can withdraw from the study at any time, without giving a reason. Your rights will not be affected, and you will receive at least partial compensation, depending on the time invested. If you wish to withdraw, you can click the option 'withdraw' in the data donation portal (accessed via a link sent to your email) or contact the researcher or the PI for assistance.

We will stop using your data in any publications or presentations after you have withdrawn consent. However, we will keep copies of your original consent, and of your withdrawal request.

What will happen if I decide to take part?

01. Sign up for the study

02. Request your user data from Amazon UK

03. Donate one anonymous data file for research

04. Answer to three questionnaires

→ Receive 5 pounds as compensation for your time

The study is conducted online, and it involves answering to questionnaires, requesting your Amazon Kindle user data from Amazon UK, and donating one anonymous data file for research purposes. You will be compensated with 5 pounds for taking part, and the study should take approximately 45 minutes to complete (over multiple days).

First, you will be asked to sign up for the study by entering your email address on the study landing page. You will be sent an automatic email that has information on the study, instructions on how you can request your Amazon UK Kindle user data from an Amazon website, and a personalised link to access the study data donation portal.

After signing up for the study, you will be asked to request your Amazon Kindle user data. The data request takes approximately 2-10 days to process. You will receive an email from Amazon UK when the data request has been finalised.

Once you have received the data request, access the study data donation portal by clicking on the link in the initial information email. In the portal, you will be asked to fill in two questionnaires about your reading habits and preferences.

After responding to the questionnaires, you will be asked to donate one of the files included in your Amazon user data. The data file, called *Kindle.Devices.ReadingSession.zip*, includes information on the timings and durations of your reading sessions on Amazon Kindle devices or applications. The file also includes detail on which devices you have used, which books you have read, and how many times you turned a page during a reading session. The file is fully anonymous and does not include any sensitive data. We will only ask you to upload this data file to the study data donation portal, and the system will automatically check that the correct file is uploaded.

After uploading the data, you will be asked to respond to a final questionnaire on the books mentioned in your donated data file. In the questionnaire, you will be shown the covers, titles, and authors of the books mentioned in the data file. You will be asked to report whether you have read each book, and if so, whether you enjoyed it, and what was your primary reason for reading it.

After responding to the questionnaires and uploading the data file, you will be asked to input your email address so that the researcher can contact you about the payment of 5 pounds. This sum is paid in compensation for your time. You will also receive an email with additional information on the study.

Compensation.

You will be paid £5 for your participation in this study. Payment can be received via PayPal or as an Amazon voucher.

Are there any risks associated with taking part?

There are no significant risks associated with participation.

What will happen to the results of this study?

The results of this study may be summarised in published articles, reports, and presentations. Quotes or key findings will be anonymized: We will remove any information that could, in our assessment, allow anyone to identify you. With your consent, information can also be used by others for future research and learning. Your data may be archived for a minimum of 2 years.

Data protection and confidentiality.

Your data will be processed in accordance with Data Protection Law. All information collected about you will be kept strictly anonymous. Your data will be referred to by a unique participant number rather than by name. Your data will only be viewed by the researcher, supervisors, and the website developer. The data is stored and collected anonymously.

All data will be stored in secure databases and on a password-protected computer.

What are my data protection rights?

The University of Edinburgh is a Data Controller for the information you provide. You have the right to access information held about you. Your right of access can be exercised in accordance to Data Protection Law. You also have other rights including rights of correction, erasure, and objection. For more details, including the right to lodge a complaint with the Information Commissioner's Office, please visit www.ico.org.uk. Questions, comments, and requests about your personal data can also be sent to the University Data Protection Officer at dpo@ed.ac.uk.

Who can I contact?

If you have any further questions about the study, please contact the lead researcher, Pauliina Vuorinen at p.t.e.vuorinen@sms.ed.ac.uk or the PI Frank Keller at keller@inf.ed.ac.uk

If you wish to make a complaint about the study, please contact inf-ethics@inf.ed.ac.uk. When you contact us, please provide the study title, and detail the nature of your complaint.

Updated information.

If the research project changes in any way, an updated Participant Information Sheet will be made available on web.inf.ed.ac.uk/infweb/research/study-updates.

Alternative formats.

To request this document in an alternative format, such as large print or on coloured paper, please contact Pauliina Vuorinen at p.t.e.vuorinen@sms.ed.ac.uk

General information.

For general information about how we use your data, go to: edin.ac/privacy-research

Continue

This study is conducted by a research team in the University of Edinburgh and University of Aberdeen. The study is non-commercial, and not affiliated with or endorsed by Amazon.

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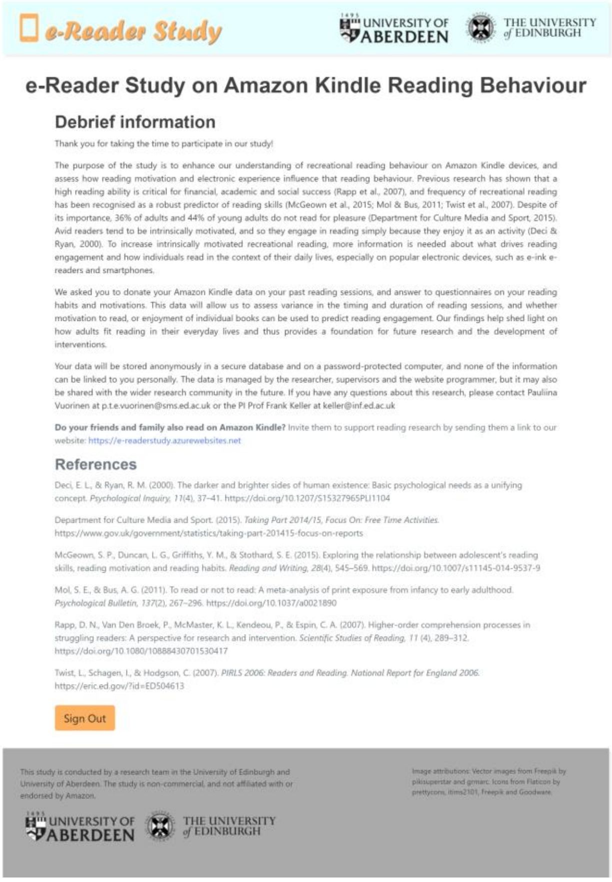
Note. For a full resolution version, see https://pauliinav.github.io/Natural_e-Reading_Behaviour_Materials/Appendices/AppB_InfoSheetCh6.png

Figure B9

Debrief Sheet as it was Shown in the e-Reader Study Portal.



e-Reader Study

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e-Reader Study on Amazon Kindle Reading Behaviour

Debrief information

Thank you for taking the time to participate in our study!

The purpose of the study is to enhance our understanding of recreational reading behaviour on Amazon Kindle devices, and assess how reading motivation and electronic experience influence that reading behaviour. Previous research has shown that a high reading ability is critical for financial, academic and social success (Rapp et al., 2007), and frequency of recreational reading has been recognised as a robust predictor of reading skills (McGeown et al., 2015; Mol & Bus, 2011; Twist et al., 2007). Despite of its importance, 36% of adults and 44% of young adults do not read for pleasure (Department for Culture Media and Sport, 2015). Avid readers tend to be intrinsically motivated, and so they engage in reading simply because they enjoy it as an activity (Deci & Ryan, 2000). To increase intrinsically motivated recreational reading, more information is needed about what drives reading engagement and how individuals read in the context of their daily lives, especially on popular electronic devices, such as e-ink e-readers and smartphones.

We asked you to donate your Amazon Kindle data on your past reading sessions, and answer to questionnaires on your reading habits and motivations. This data will allow us to assess variance in the timing and duration of reading sessions, and whether motivation to read, or enjoyment of individual books can be used to predict reading engagement. Our findings help shed light on how adults fit reading in their everyday lives and thus provides a foundation for future research and the development of interventions.

Your data will be stored anonymously in a secure database and on a password-protected computer, and none of the information can be linked to you personally. The data is managed by the researcher, supervisors and the website programmer, but it may also be shared with the wider research community in the future. If you have any questions about this research, please contact Pauliina Vuorinen at p.t.e.vuorinen@sms.ed.ac.uk or the PI Prof Frank Keller at keller@inf.ed.ac.uk

Do your friends and family also read on Amazon Kindle? Invite them to support reading research by sending them a link to our website: https://e-readerstudy.azurewebsites.net

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Sign Out

This study is conducted by a research team in the University of Edinburgh and University of Aberdeen. The study is non-commercial, and not affiliated with or endorsed by Amazon.

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Appendix C

Information Used in Text Selection Procedures

Chapter 4: Short Story Summaries

In the study described in Chapter 4, participants rated their interest in reading one of nine different short stories after having read short summaries on each one. See more detail in Chapter 4 method section.

Note that information about one of the stories is not shared because it was mistaken to have a Creative Commons license.

Table C1

Summaries Used for each Short Story in the Text Selection Procedure.

Title	Author	Summary
The Adventures of Sherlock Holmes: The Boscombe Valley Mystery	Arthur Conan Doyle	Mr McCarthy had an appointment of importance to keep at three. From that appointment he never came back alive. A very serious case has been established against the son of the murdered man. But I shall approach this case from the point of view that what this young man says is true, and he is innocent, and we shall see whither that hypothesis will lead us.
Preparations and Alliances	Ryk E. Spoor	'There is a significant chance that one of our adversaries may target you, Saul. We see great changes coming, perhaps great wars, and whoever leads us must be one who can face any Challenge head-on.' Mentor said. Saul Maginot stood at the entryway for the shuttle. Mentor was considered a rogue AI and would be destroyed upon detection. If Saul were connected with the release or aid of a rogue AI, the destruction of his career would be the least of his problems.
-	-	-
Gigolo: Not a Day over Twenty-One	Edna Ferber	At thirty-seven Harrietta Fuller had been fifteen years on the stage. She had little money, a small stanch following, an exquisite technique, and her fur coat was beginning to look gnawed around the edges. Harrietta knew she wasn't a success. But Ken thought she was the most beauteous, witty, intelligent woman in the world, although he had never told her so, and Harrietta found herself wishing he would.
The Thing on the Doorstep	H.P. Lovecraft	At times Derby would halt abruptly in his revelations, and I wondered whether his wife could possibly have divined his speech at a distance and cut him off through some unknown sort of telepathic mesmerism. The figure beside me seemed less like a lifelong friend than like some monstrous intrusion from outer space. He would let fall remarks about things 'going too far'.
The Million Pound Bank Note	Mark Twain	What might be the fate of a perfectly honest and intelligent stranger who should be turned adrift in London without a friend, and with no money but a million-pound-bank-note. Brother B said he would bet twenty thousand pounds that the man would live thirty days, anyway, on that million, and keep out of jail, too. Brother A took him up. They agreed that I filled the bill all around; so they elected me unanimously.

The Yates Pride	Mary E. Wilkins Freeman	Harry Lawton had come back. Eudora did not know him at first, but as they drew nearer each other, she knew. He had not made a failure of his life, even though it had not included Eudora and a fulfilled dream.
Through Russia: The Icebreaker	Maxim Gorky	Everywhere the ice was sparkling as though in derision of ourselves. 'Let every man take a plank, and hold it in front of him. Then, should anyone fall in (which God forbid!), the plank-ends will catch upon the ice to either side of him, and hold him up. None but a fool gets drowned.'
The Most Dangerous Game	Richard Connell	This place has an evil name among seafaring men. Even cannibals wouldn't live in such a God-forsaken place. Rainsford heard a sound. It came out of the darkness, a high screaming sound, the sound of an animal in an extremity of anguish and terror.

Note. Information about one of the stories is redacted because it was mistaken to have a Creative Commons licence. Summaries were constructed by annotators who extracted sentences from the short stories to make sure that the summaries were representative of the writing style of the stories. Chapter 5: Information on Each of the Available Books in Sirius Reader Library.

Chapter 5: Text Selection Procedure

In Chapter 5, participants were allowed to select their own reading material from a selection of 16 different books. The selection was done in Sirius Reader library, where participants could view the cover, title, author and additional information on each book. The additional information included the following:

- Under ‘details:’
  - Book length in pages
  - When and where the book was published
  - Book genre
  - Whether the book was part of a series or not
  - Information on the author from Goodreads.com
- Under ‘reviews:’
  - Average rating in Goodreads.com and number of reviews
  - Two to three recent reviews from Goodreads.com, shown with the reviewers’ permission
- Synopsis from Goodreads.com
- First page of the book

The information that was shown under ‘details’ and ‘reviews’ sections in the library can be viewed for each book in this repository: https://github.com/PauliinaV/Natural_e-Reading_Behaviour_Materials/tree/main/Appendices/BookInformation

Appendix D

Information on Mixed Model Structures

Chapter 4

Table D1

Additional Information on the Mixed Models in Chapter 4.

Model Version	Reading Behaviour	Model Type	Number of Observations	Number of Fixed Effect Parameters	Number of Random Effect Parameters
Reader Characteristics					
	Task-switching (TS1)	Linear Mixed Model	253	11	2
	Reading speed (RS1)	Linear Mixed Model	1,936	14	2
	Linearity (LIN1)	Generalised Linear Mixed Model	147	14	1
Task-contexts					
	Task-switching (TS2)	Linear Mixed Model	3,939	19	3
	Reading speed (RS2)	Linear Mixed Model	1,816	12	6
	Linearity (LIN2)	Generalised Linear Mixed Model	3,819	20	6

Table D2

Information on Mixed Model Structure Selection in Chapter 4.

Model Indicator	Information on model selection
TS1	The maximal interactive model was singular, and so it was simplified by backward selection of random slopes. All slopes were removed from the model before it reached convergence and was no longer singular.
RS1	The maximal interactive model was singular, and so it was simplified by backward selection of random slopes. All slopes were removed from the model before it reached convergence and was no longer singular.
LIN1	The maximal interactive model was singular. Backward selection of the random slopes and fixed effects did not resolve the issue. Inspection showed that the singularity was due to the random intercept of story indicator which accounted for zero variance in the model. Attempts to fit story indicator as a fixed effect resulted in multicollinearity in the model, and thus story indicator was removed from the model structure.
TS2	The additive model was singular due to the random intercept of story indicator which accounted for zero variance in the model. Story indicator was fit in the model as a fixed effect, however, one of the short story groups had too few observations, and so this level could not be included in the model. This change resulted in the removal of three continuous engagement duration observations from three different participants, and thus our sample size used for the task-switching analysis for task-contexts model was 57 rather than 60 participants. This was decided to be preferrable for removing story indicator from the model entirely. Once story indicator was successfully fit as a fixed effect in the additive model, the following random slopes were added to the adjusted model: time since the beginning of reading session, location in text and browser window width. The additive model was singular after slope selection, and so slopes were selected backward stepwise. The additive model reached convergence after removal of the random slopes of location in text and window width. Interactions were added to the model and the full interactive model structure reached convergence.
RS2	The following random slopes were added to the additive model: location in text, and days until reading deadline. However, this model did not converge, and so random slopes were selected backward stepwise. The additive model to converge only included a random slope of days until reading deadline. Two-way interactions were then added to the model, and the full interactive model reached convergence.
LIN2	The additive model was singular due to the random intercept of story indicator which accounted for zero variance in the model. Story indicator was successfully fit as a fixed effect in the additive model, and the following random slopes were added to the adjusted model: time in a reading session, window width, location in text, reading session number, and event k-1. The additive model was singular after slope selection, and random slopes were selected backward stepwise. The additive model reached convergence after removal of the random slopes of location in text, window width, and reading session number. Interactions were then added to the model and the full interactive model structure reached convergence.

Note. See Table D1 for the model indicators.

Table D3

Information on Mixed Model Structures in Chapter 4.

Model Indicator	Model Structure
TS1	log(Continuous engagement duration in minutes + 1) = Window Width + Days until reading deadline + Native speaker + Autonomy condition + Situational competence + Contextual motivation + Contextual competence + Electronic device types + Electronic text types + Electronic device types x Electronic text types + (1 | Story indicator) + (1 | Participant indicator)
RS1	Deep reading variance from baseline = Window width + Days until reading deadline + Native speaker + Autonomy Condition + Situational competence + Contextual motivation + Contextual competence + Electronic device types + Electronic text types + Electronic device types x Electronic text types + Condition x Situational competence + Contextual interest x Situational competence + Electronic device types x Electronic text types x Situational competence + (1 | Story indicator) + (1 | Participant indicator)
LIN1	Whether an event initiates nonlinearity or not = Window width + Days until reading deadline + Native speaker + Autonomy Condition + Situational competence + Contextual motivation + Contextual competence + Electronic device types + Electronic text types + Electronic device types x Electronic text types + Condition x Situational competence + Contextual motivation x Situational competence + Electronic device types x Electronic text types x Situational competence + (1 | Participant indicator)
TS2	log(Continuous engagement duration in minutes + 1) = Story indicator + Window Width + Days until reading deadline + Event(k-1) + Event(k-2) + Reading session number + Time in reading session + Location in text + Event(k-1) x Event(k-2) + Reading session number x Time since the beginning of the reading session + Reading session number x Location in text + Time since the beginning of the reading session x Location in text + (1 + Time since the beginning of the reading sessions | Participant indicator)
RS2	Deep reading variance from baseline = Window width + Days until reading deadline + Event(k-1) + Event(k-2) + Reading session number + Time in reading session + Location in text + Event(k-1) x Event(k-2) + Reading session number x Time in reading session + Reading session number x Location in text + Time in reading session x Location in text + (1 + Days until reading deadline | Story indicator / Participant indicator)
LIN2	Whether an event initiates nonlinearity or not = Story indicator + Window width + Days until reading deadline + Event(k-1) + Event(k-2) + Reading session number + Time in reading session + Location in text + Event(k-1) x Event(k-2) + Reading session number x Time in reading session + Reading session number x Location in text + Time in reading session x Location in text + (1 + Time in reading session + Event(k-1) | Participant indicator)

Note. See Table D1 for model indicators.

Chapter 5

Table D4

Additional Information on the Mixed Models from Chapter 5

Model Version	Reading Behaviour	Model Type	Number of Participants	Number of Observations	Number of Fixed Effect Parameters	Number of Random Effect Parameters
Reader Characteristics						
	Reading Persistence (Per RC 1)	Generalised linear mixed model	692	692	11	1
	Reading Persistence (Per RC 2)	Linear mixed model	420	420	19	3
	Reading Frequency (Freq RC 1)	Linear mixed model	505	2,477	12	2
	Reading Frequency (Freq RC 2)	Linear mixed model	375	2,086	19	2
	Task-switching (TS RC 1)	Linear mixed model	712	10,284	27	1
	Task-switching (TS RC 2)	Linear mixed model	442	8,772	33	1
	Reading Speed (RS RC 1)	Linear mixed model	710	216,139	12	2
	Reading Speed (RS RC 2)	Linear mixed model	442	195,472	22	4
	Linearity (LIN RC 1)	Generalised linear mixed model	714	315,176	12	2
	Linearity (LIN RC 2)	Generalised linear mixed model	442	283,825	22	4
Task-contexts						
	Reading Frequency (Freq TC)	Linear mixed model	505	2,477	12	2
	Task-switching (TS TC)	Linear mixed model	581	8,933	35	1

Reading Speed (RS TC)	Linear mixed model	701	214,721	20	12
Linearity (LIN TC)	Generalised linear mixed model	711	313,750	20	30

Table D5

Information on Mixed Model Selection in Chapter 5

Model Indicator	Information on model selection
Per RC 1	The original model with a continuous outcome variable was found to have a bimodal distribution. As a result, an alternative model was fit with a binary outcome variable. The maximal model was singular, and so it was simplified by backward selection of random slopes. The model converged after removal of the random slope of contextual motivation. Visual inspection of outliers by Cook's distance indicated one potentially influential observation, however, removal of the observation did not influence model interpretations and so the observation was retained in the model. The model aligned with all assumptions.
Per RC 2	The maximal interactive model was singular, and so it was simplified by backward selection of random slopes. The model converged after removal of the random slopes of situational and contextual motivation. The model aligned with all assumptions.
Freq RC 1	The maximal model was singular, and so it was simplified by backward selection of random slopes. The model converged after removal of the random slope of contextual motivation. Inspection of normality of random effects showed that user indicator showed significant variation from normality, The qq-plot showed long tails, however, otherwise the distribution was found to follow the reference line. Considering that Shapiro Wilk test is affected by large n, we assumed normality of random effects. As a result, the model aligned with all assumptions.
Freq RC 2	The maximal model was signular, and so it was simplified by backward selection of random slopes. The model converged after removal of all random slopes. The residual variances in the model were found to not vary systematically, which we attempted to resolve with a Box-cox transformation. The transformation did not address the heteroscedasticity in the model, and so the assumption could not be fulfilled. Therefore, the model accuracy in predicting low and high values was compromised. This issue does not bias the coefficients in the model or their interpretation, and so this violation was considered to be acceptable as we did not make predictions beyond the observations. The random effect of user indicator was found to have a non-normal distribution based on Shapiro Wilk test, however, considering that qq-plots indicated a roughly normal distribution, we assumed normality. The model aligned with all assumption apart from homoscedasticity.
TS RC 1	Inspection of the model values showed that the random effect of book indicator had one outlier, which resulted in significant variation from normality in the random effect. Book indicator was fit as a fixed effect in the model with helmert contrasts. The adjusted model reached convergence. The model was found to be heteroscedastic, and a box-cox transformation did not address the issue. This was considered to be acceptable considering that we did not make predictions on the basis of the model, and only interpreted coefficients. The adjusted model aligned with all assumptions apart from homoscedasticity.
TS RC 2	Similarly to the first reader characteristics model, this model was adjusted to address an issue with nonnormality of book indicator as a random effect. The issue was resolved by fitting book indicator as a fixed rather than a random effect. The model was found to be heteroscedastic, which was resolved with fitting the outcome variable with a box-cox transformation. The adjusted model aligned with all assumptions.
RS RC 1	The maximal model reached convergence. The model was found to be heteroscedasticity, which was not resolved by a box-cox transformation. As a result,

	the assumption of homoscedasticity could not be fulfilled, which we accepted as no predictions were made on the basis of this model. The random intercept of user indicator was found to be nonnormal on the basis of Shapiro Wilk test, however, qq-plots suggested a roughly normal distribution and so we assumed normality of random effects. The model was found to align with all assumptions apart from homoscedasticity.
RS RC 2	The maximal interactive model was found to be singular, and so it was simplified by backward selection of randoms slopes. The model reached convergence after removal of two random slopes, an interaction between situational competence and situational motivation, and an interaction between situational competence and contextual motivation. Similarly to the first reader characteristics model, this model was affected by heteroscedasticity that was not resolved by a box-cox transformation. The model aligned with all assumptions apart from homoscedasticity.
LIN RC 1	The maximal model converged. The model was affected by heteroscedasticity, which we accepted considering that no predictions were made beyond the observations. The random intercept of user indicator was found to have a nonnormal distribution, which could not be resolved by removing participants with extreme values. This limitation affects the random effect's variance estimation but it does not bias interpretation of fixed effect coefficients, and so this limitation was accepted. The model aligned with assumptions for multicollinearity and influential observations.
LIN RC 2	The maximal interactive model was singular, and so it simplified by backward selection of random slopes. The model converged after removal of two random slopes, an interaction between situational competence and the two task-relevant electronic reading experience measures, and an interaction between situational competence and contextual motivation. Similarly to the first reader characteristics model, this model was affected by heteroscedasticity, which we accepted considering that no predictions were made beyond the observations. The random intercept of user indicator was found to have a nonnormal distribution, which could not be resolved by removing participants with extreme values. This limitation affects the random effect's variance estimation but it does not bias interpretation of fixed effect coefficients, and so this limitation was accepted. The model aligned with assumptions for multicollinearity and influential observations.
Freq TC	The best-path algorithm led us to include three random slopes in the additive model: days until end of study, location in text, and reading session number. The additive was singular, however, and so it was simplified by backward stepwise selection of random slopes. The model reached convergence after removal of all random slopes. The interactive model structure converged. The interactive model was affected by heteroscedasticity tat was not resolved by a box-cox transformation. The homoscedasticity in the model was accepted as the model was not used for making predictions beyond observations. The random intercept of user indicator was found to significantly vary normality. The nonnormality could not be resolved by removing outliers or by fitting the indicator as a fixed effect, and so the violation was accepted. The nonnormality affects the reliability of user indicator variance estimation, but it does not affect interpretation of fixed effect coefficients. The model aligned with assumptions for multicollinearity and influential observations.
TS TC	The best-path algorithm led us to include five random slopes: window width, reading location, reading session number, Event k-1 and Event k-2. The additive model was singular and nonconvergent, and so it was simplified by backward selection of random slopes. The model converged after removal of all random slopes. The interactive model converged. The interactive model was affected by heteroscedasticity, which was not resolved by box-cox transformation. The homoscedasticity in the model was accepted as the model was not used for making predictions beyond observations. The random intercept of book indicator showed considerable variance from normality, and so book

	indicator was fit as a fixed effect with helmert contrasts. The adjusted model aligned with all assumptions apart from homoscedasticity.
RS TC	The best-path algorithm led us to include eight random slopes: location in text, Event k-1, time in reading session, Event k-2, reading location, window width, days until end of study, and reading session number. The additive model was found to be singular and nonconvergent, and so it was simplified by backward selection of random slopes. The additive model after removal of all but two slopes (days until end of study and reading session number). The interactive model converged. The interactive model was affected by heteroscedasticity, which could not be resolved by a box-cox transformation. The homoscedasticity in the model was accepted as the model was not used for making predictions beyond observations. Random intercept of user indicator was nonnormal according to Shapiro Wilk test, however, we assumed normality as the qq-plot showed that the distribution fit the reference line. Random intercept of book indicator, on the other hand, showed considerable variance for normality, which could not be resolved. We accept this limitation and so the book indicator random effect variance is not reliable, however, this issue does not affect our interpreation of fixed effect coefficients, which was our aim. The model aligned with assumptions for multicollinearity and influential observations.
LIN TC	The best-path algorithm led us to include six random slopes: Event k-1, location in text, Event k-2, time in a reading session, reading location, and window width. The additive random slopes model was singular and nonconvergent, and so it was simplified by backward selection of random slopes. The model converged after removal of three random slopes (location in text, time in a reading session, and window width). The interactive model converged. The interactive model was affected by heteroscedasticity, which we accepted as a limitation of the model considering that no predictions were made beyond observed values. Random intercepts of user and book indicator were found to result in significant nonnormality which could not be resolved by removing extreme observation or fitting the random effects as fixed effects. This violation reduces the reliability of the random effect intercept variation, however, it does not affect interpreation of fixed effect coefficients. Considering that the latter was our main objective, this limitation was accepted. The model aligned with assumptions for multicollinearity and influential observations.

Note. See Table D4 for the model indicators.

Table D6

Information on Mixed Model Structures in Chapter 5

Model Indicator	Model Structure
Per RC 1	Whether infographic was reached or not ~ Window Width + Days Until End Of Study + Whether participant completed study or not + Age + Gender: F vs M, Other vs F/M + Education level: Tertiary vs lower + Whether participant is a native English speaker or not + Contextual motivation + Contextual competence + ART score + (1 | Book ID)
Per RC 2	log(Proximity To Infographic Threshold + 180) ~ Window Width + Days Until End Of Study + Whether participant provided neg. feedback or not + Age + Gender: F vs M, Other vs F/M + Education level: Tertiary vs lower + Whether participant is a native English speaker or not + Situational Motivation + Situational Competence + Situational Autonomy + Contextual motivation + Contextual Competence + Electronic text type experience + Electronic device type experience + ART score + Electronic text type experience x Electronic device type experience + Age x Electronic text type experience x Electronic device type experience + (1 + Electronic text type experience x Electronic device type experience | Book ID)
Freq RC 1	log(Time Between Reading Sessions + 2) ~ Whether participant completed study or not + Window Width + Days Until End Of Study + Age + Gender: F vs M, Other vs F/M + Education level: Tertiary vs lower + Whether participant is a native English speaker or not + Contextual Motivation + Contextual Competence + ART score + (1 | Book ID) + (1 | User ID)
Freq RC 2	log(Time Between Reading Sessions + 2) ~ Days Until End Of Study + Window Width + Whether participant provided neg. feedback or not + Age + Gender: F vs M, Other vs F/M + Education level: Tertiary vs lower + + Whether participant is a native English speaker or not +Situational Motivation + Situational Competence + Situational Autonomy + Contextual motivation + Contextual Competence + Electronic text type experience + Electronic device type experience + ART score + Electronic text type experience x Electronic device type experience + Age x Electronic text type experience x Electronic device type experience + (1 | Book ID) + (1 | User ID)
TS RC 1	log(Continuous Engagement Duration in Minutes + 2) ~ Book ID + Whether participant completed study or not + Window Width + Days Until End Of Study + Age + Gender: F vs M, Other vs F/M + Education level: Tertiary vs lower + Whether participant is a native English speaker or not + Contextual Motivation + Contextual Competence + ART score + (1 | User ID)
TS RC 2	Continuous Engagement Duration in Minutes (BC transformed) ~ Book ID + Window Width + Days Until End Of Study + Whether participant provided neg. feedback or not + Age + Gender: F vs M, Other vs F/M + Education level: Tertiary vs lower + + Whether participant is a native English speaker or not + Situational Motivation + Situational Competence + Situational Autonomy + Contextual motivation + Contextual Competence + Electronic text type experience + Electronic device type experience + ART score + Electronic text type experience x Electronic device type experience + Age x Electronic text type experience x Electronic device type experience + (1 | User ID)
RS RC 1	Deep Reading Rate ~ Whether participant completed study or not + Window Width + Days Until End Of Study + Age + Gender: F vs M, Other vs F/M + Education level: Tertiary vs lower + Whether participant is a native English speaker or not + Contextual Motivation + Contextual Competence + ART score + (1 | Book ID) + (1 | User ID)

RS RC 2	Deep Reading Rate ~ Window Width + Days Until End Of Study + Whether participant provided neg. feedback or not + Age + Gender: F vs M, Other vs F/M + Education level: Tertiary vs lower + + Whether participant is a native English speaker or not + Situational Motivation + Situational Competence + Situational Autonomy + Contextual motivation + Contextual Competence + Electronic text type experience + Electronic device type experience + ART score + Electronic text type experience x Electronic device type experience + Situational Competence. x Situational Motivation + Situational Competence x Contextual Motivation + Situational Competence x ART score + Situational Competence x Electronic text type experience x Electronic device type experience + (1 + Situational Competence x Electronic text type experience x Electronic device type experience | Book ID) + (1 | User ID)
LIN RC 1	Whether page-view initiates nonlinear navigation or not ~ Whether participant completed study or not + Window Width + Days Until End Of Study + Age + Gender: F vs M, Other vs F/M + Education level: Tertiary vs lower + Whether participant is a native English speaker or not + Contextual Motivation + Contextual Competence + ART score + (1 | Book ID) + (1 | User ID)
LIN RC 2	Whether page-view initiates nonlinear navigation or not ~ Window Width + Days Until End Of Study + Whether participant provided neg. feedback or not + Age + Gender: F vs M, Other vs F/M + Education level: Tertiary vs lower + + Whether participant is a native English speaker or not + Situational Motivation + Situational Competence + Situational Autonomy + Contextual motivation + Contextual Competence + Electronic text type experience + Electronic device type experience + ART score + Electronic text type experience x Electronic device type experience + Age x Electronic text type experience x Electronic device type experience + Situational Competence x Situational Motivation + Situational Competence x Contextual Motivation + Situational Competence x Electronic text type experience x Electronic device type experience + (1 + Situational Competence x Situational Motivation | Book ID) + (1 | User ID)
Freq TC	log(Time Between Reading Sessions + 2) ~ Window Width + Days Until End Of Study + Reading Session Number + Location in text + Reading location: home vs outside of home + Reading Session Number x Location in text + Reading Session Number x Reading location: home vs outside of home + Location in text x Reading location: home vs outside of home + (1 | Book ID / User ID)
TS TC	log(Continuous Engagement Duration in Minutes + 2) ~ Book ID + Window Width + Days Until End Of Study + Event k-1 + Event k-2 + Reading Session Number + Time In Reading Session + Location in Text + Reading location: home vs outside of home + Event k-1 x Event k-2 + Reading Session Number x Time In Reading Session + Reading Session Number x Location in text + Reading Session Number x Reading location: home vs outside of home + Time In Reading Session x Location in text + Time In Reading Session x Reading location: home vs outside of home + Location in text x Reading location: home vs outside of home + (1 | User ID)
RS TC	Deep Reading Rate ~ Window Width + Days Until End Of Study + Event k-1 + Event k-2 + Reading Session Number + Time In Reading Session + Location in Text + Reading location: home vs outside of home + Event k-1 x Event k-2 + Reading Session Number x Time In Reading Session + Reading Session Number x Location in Text + Reading Session Number x Reading location: home vs outside of home + Time In Reading Session x Location in Text + Time In Reading Session x Reading location: home vs outside of home + Location in Text x Reading location: home vs outside of home + (1 + Days Until End Of Study + Reading Session Number | Book ID / User ID)

LIN TC	Whether page-view initiates nonlinear navigation or not ~ Window Width + Days Until End Of Study + Event k-1 + Event k-2 + Reading Session Number + Time In Reading Session + Location in Text + Reading location: home vs outside of home + Event k-1 x Event k-2 + Reading Session Number x Time In Reading Session + Reading Session Number x Location in Text + Reading Session Number x Reading location: home vs outside of home + Time In Reading Session x Location in Text + Time In Reading Session x Reading location: home vs outside of home + Location in Text x Reading location: home vs outside of home + (1 + Event k-1 + Event k-2 + Reading Session Number + Location in Text | Book ID / User ID)

Note. See Table D4 for the model indicators.

Chapter 6

Table D7

Additional Information on the Mixed Models from Chapter 6

Model Version	Reading Behaviour	Sample type	Model Type	Number of Participants	Number of Observations	Number of Fixed Effect Parameters	Number of Random Effect Parameters
Reader Characteristics							
	Reading Frequency (Freq RC 1)	Full sample, inc. unidentified books	Linear mixed model	26	7,549	11	3
	Reading Frequency (Freq RC 2)	Only identified fiction	Linear mixed model	25	3,261	11	3
	Reading Frequency (Freq RC 3)	Only books that were responded to in book questionnaire	Linear mixed model	25	2,114	11	5
	Task-switching (TS RC 1)	Full sample, inc. unidentified books	Linear mixed model	30	30,956	11	7
	Task-switching (TS RC 2)	Only identified fiction	Linear mixed model	26	14,203	11	5
	Task-switching (TS RC 3)	Only books that were responded to in book questionnaire	Linear mixed model	30	30,956	11	7
Task-contexts							

Reading Frequency (Freq TC)	Full sample, inc. unidentified books	Linear mixed model	26	7,549	5	12
Task-switching (TS TC 1)	Full sample, inc. unidentified books	Linear mixed model	29	30,896	8	14
Task-switching (TS TC 2)	Only identified fiction	Linear mixed model	26	14,174	7	14

Table D8

Information on Mixed Model Selection in Chapter 6

Model Indicator	Information on model selection
Freq RC 1	The maximal interactive model was singular, and so it was simplified by backward selection of random slopes. The model converged after removal of all random slopes. Inspection of multicollinearity by correlation matrices showed that contextual motivation and contextual competence were highly correlated. The model was re-fit without contextual competence, however, the original model was used as removing contextual competence did not affect model interpretation. The model was found to be heteroscedastic, which was not resolved by a box-cox transformation. The heteroscedasticity compromises the model accuracy in prediction, however, considering that our aim was to interpret model coefficients without forecasting beyond observed values, this limitation was considered to be acceptable. The random intercept of book indicator was found to vary from normal distribution. This affects reliability of random effect variance estimates, however, it has no effect on fixed effect coefficients. We accepted this limitation.
Freq RC 2	The maximal interactive model was singular, and so it was simplified by backward selection of random slopes. The model converged after removal of all random slopes. Inspection of multicollinearity by correlation matrices showed that contextual motivation and contextual competence were highly correlated. The model was re-fit without contextual competence, however, the original model was used as removing contextual competence did not affect model interpretation. The model was found to be heteroscedastic, which was not resolved by a box-cox transformation. The heteroscedasticity compromises the model accuracy in prediction, however, considering that our aim was to interpret model coefficients without forecasting beyond observed values, this limitation was considered to be acceptable. The random intercept of book indicator was found to vary from normal distribution. This affects reliability of random effect variance estimates, however, it has no effect on fixed effect coefficients. We accepted this limitation.
Freq RC 3	The maximal interactive model was singular, and so it was simplified by backward selection of random slopes. The model converged after removal of all random slopes but contextual motivation. Inspection of multicollinearity by correlation matrices showed that contextual motivation and contextual competence were highly correlated. The model was re-fit without contextual competence, however, the original model was used as removing contextual competence did not affect model interpretation. The model was found to be heteroscedastic, which was not resolved by a box-cox transformation. The heteroscedasticity compromises the model accuracy in prediction, however, considering that our aim was to interpret model coefficients without forecasting beyond observed values, this limitation was considered to be acceptable. The random intercept of book indicator was found to vary from normal distribution. This affects reliability of random effect variance estimates, however, it has no effect on fixed effect coefficients. We accepted this limitation.
TS RC 1	The maximal interactive model was singular and nonconvergent, and so it was simplified by backward selection of random slopes. The model converged after removing two random slopes: an interaction between task-relevant electronic reading experience measures as a random slope of device indicator and random slope of contextual motivation from random effect of book indicator. Inspection of multicollinearity by correlation matrices showed that contextual motivation and contextual competence were highly correlated. The model was re-fit without contextual competence, however, the original model was used as removing contextual

	competence did not affect model interpretation. The model was found to be heteroscedastic, which was not resolved by a box-cox transformation. The heteroscedasticity compromises the model accuracy in prediction, however, considering that our aim was to interpret model coefficients without forecasting beyond observed values, this limitation was considered to be acceptable. The random intercept of book indicator was found to vary from normal distribution. This affects reliability of random effect variance estimates, however, it has no effect on fixed effect coefficients. We accepted this limitation.
TS RC 2	The maximal interactive model was singular, and so it was simplified by backward selection of random slopes. The model converged after removing three random slopes: an interaction between task-relevant electronic reading experience measures as a random slope of device indicator and book indicator, and random slope of contextual motivation from random effect of device indicator. Inspection of multicollinearity by correlation matrices showed that contextual motivation and contextual competence were highly correlated. The model was re-fit without contextual competence, however, the original model was used as removing contextual competence did not affect model interpretation. The model was found to be heteroscedastic, which was not resolved by a box-cox transformation. The heteroscedasticity compromises the model accuracy in prediction, however, considering that our aim was to interpret model coefficients without forecasting beyond observed values, this limitation was considered to be acceptable. The random intercept of book indicator was found to vary from normal distribution. This affects reliability of random effect variance estimates, however, it has no effect on fixed effect coefficients. We accepted this limitation.
TS RC 3	The maximal interactive model was singular, and so it was simplified by backward selection of random slopes. The model converged after removing five random slopes. Inspection of multicollinearity by correlation matrices showed that contextual motivation and contextual competence were highly correlated. The model was re-fit without contextual competence, however, the original model was used as removing contextual competence did not affect model interpretation. The model was found to be heteroscedastic, which was not resolved by a box-cox transformation. The heteroscedasticity compromises the model accuracy in prediction, however, considering that our aim was to interpret model coefficients without forecasting beyond observed values, this limitation was considered to be acceptable. The random intercept of book indicator was found to vary from normal distribution. This affects reliability of random effect variance estimates, however, it has no effect on fixed effect coefficients. We accepted this limitation.
Freq TC	The best-path algorithm led us to include three slopes in the additive model: reading session number, whether device is an e-ink e-reader or not, and whether book is confirmed to be fiction or not. The additive random slopes model was singular, and so it was backward selected. The following three random slopes were removed before the model converged: whether book was confirmed to be fiction or not as a slope of device indicator, reading session number as a slope of user indicator, and whether device was an e-ink e-reader as a slope of user indicator. The interactive model converged. Inspection of Cook's Distances by visualisation indicated that the model may be affected by influential observations. The model was re-fit without the observation with the highest Cook's Distance, however, its removal did not influence model interpretation, and so the model was assumed to not have influential observations. The model was found to be heteroscedastic, which was not resolved by a box-cox transformation. The heteroscedasticity compromises the model accuracy in prediction, however, considering that our aim was to interpret model coefficients without forecasting beyond observed values, this limitation was considered to be acceptable. The random intercept of book indicator was found to vary from normal distribution. This affects reliability of random effect variance estimates, however, it has no effect on fixed effect coefficients. We accepted this limitation.

TS TC 1	The best-path algorithm led us to include three random slopes in the addtive model: Event k-1, Event k-2, and whether device was an e-ink e-reader or not. The additive random slopes model was singular, and so random slopes were selected backward stepwise. The model reached convergence after removal of five random slopes: Event k-2 as a random slope of device and user indicator, reading session number in book indicator, Event k-1 as a random slope of device and user indicator. The interactive model converged. Inspection of Cook's Distances suggested that the model had one influential observation. The observation was removed from the model, and it was found to have a significant effect on model interpretation, and so the observation was confirmed to be influential and removed from the model. The adjusted model was singular and non-convergent, and so it was simplified backward stepwise until convergence. The model converged after removal of two more random slopes: reading session number in device indicator and whether device was an e-ink e-reader or not in user indicator. The model was found to be heteroscedastic, which was not resolved by a box-cox transformation. The heteroscedasticity compromises the model accuracy in prediction, however, considering that our aim was to interpret model coefficients without forecasting beyond observed values, this limitation was considered to be acceptable. The random intercepts of book and user indicator were found to vary from normal distribution. This affects reliability of random effect variance estimates, however, it has no effect on fixed effect coefficients. We accepted this limitation.
TS TC 2	The best-path algorithm led us to include four random slopes: Event k-1, Event k-2, whether device is an e-ink e-reader or not, and reading session number. The additive random slopes model was singular and non-convergent, and so we used backward stepwise selection starting with random slopes. The model converged after removal of seven random slopes: Event k-2 as a random slope of user and device indicator, Event k-1 as a random slope of user and device indicator, reading session number as a random slope of book and device indicator, whether device was an e-ink e-reader or not as a random slope of user indicator. The interactive model converged. Visualisation of Cook's Distances suggested that model may have influential observations. We re-fit the interactive model without the observation with the highest Cook's Distance, however, its exclusion did not influence model interpretations, and so all observations were retained in the model. The model was found to be heteroscedastic, which was not resolved by a box-cox transformation. The heteroscedasticity compromises the model accuracy in prediction, however, considering that our aim was to interpret model coefficients without forecasting beyond observed values, this limitation was considered to be acceptable. The random intercepts of book and user indicator were found to vary from normal distribution. This affects reliability of random effect variance estimates, however, it has no effect on fixed effect coefficients. We accepted this limitation.

Note. See Table D7 for the model indicators.

Table D9

Information on Mixed Model Structures in Chapter 6

Model Indicator	Model Structure
Freq RC 1	log(Time Between Reading Sessions + 1) ~ Whether book is identified as fiction or not + Age + Gender: M vs F + Education: Tertiary vs lower + Whether English is native language or not + Contextual Motivation + Contextual Competence + Electronic device types experience + Electronic text types experience + Electronic device types experience x Electronic text types experience + (1 | Book ID) + (1 | User ID) + (1 | Device ID)
Freq RC 2	log(Time Between Reading Sessions + 1) ~ Whether book was responded to in book questionnaire or not + Age + Gender: M vs F + Education: Tertiary vs lower + Whether English is native language or not + Contextual Motivation + Contextual Competence + Electronic device types experience + Electronic text types experience + Electronic device types experience x Electronic text types experience + (1 | Book ID) + (1 | User ID) + (1 | Device ID)
Freq RC 3	log(Time Between Reading Sessions + 1) ~ Age + Gender: M vs F + Education: Tertiary vs lower + Whether English is native language or not + Contextual Motivation + Contextual Competence + Situational Motivation (Book enjoyment) + Electronic device types experience + Electronic text types experience + Electronic device types experience x Electronic text types experience + (1 + Contextual Motivation | Book ID) + (1 | User ID) + (1 | Device ID)
TS RC 1	log(Continuous Engagement Duration in Minutes + 1) ~ Whether book is identified as fiction or not + Age + Gender: M vs F + Education: Tertiary or lower + Whether native language is English or not + Contextual Motivation + Contextual Competence + Electronic device types experience + Electronic text types experience + Electronic device types experience x Electronic text types experience + (1 + Electronic device types experience x Electronic text types experience | Book ID) + (1 | User ID) + (1 + Contextual Motivation | Device ID)
TS RC 2	log(Continuous Engagement Duration in Minutes + 1) ~ Whether book was responded to in book questionnaire or not +Age + Gender: M vs F + Education: Tertiary or lower + Whether native language is English or not + Contextual Motivation + Contextual Competence + Electronic device types experience + Electronic text types experience + Electronic device types experience x Electronic text types experience + (1 + Contextual Motivation | Book ID) + (1 | User ID) + (1 | Device ID)
TS RC 3	log(Continuous Engagement Duration in Minutes + 1) ~ Age + Gender: M vs F + Education: Tertiary or lower + Whether native language is English or not + Contextual Motivation + Contextual Competence + Situational Motivation (Book enjoyment) + Electronic device types experience + Electronic text types experience + Electronic device types experience x Electronic text types experience + (1 | Book ID) + (1 | User ID) + (1 + Contextual Motivation | Device ID)
Freq TC	log(Time Between Reading Sessions + 1) ~ Whether book is identified as fiction or not + Whether device is an e-ink e-reader or not + Reading session number + Whether device is an e-ink e-reader or not x Reading session number + (1 + Reading session number + Whether device is an e-ink e-reader or not | Book ID) + (1+ Whether book is identified as fiction or not | User ID) + (1 + Reading session number | Device ID)

TS TC 1	log(Continuous Engagement Duration in Minutes + 1) ~ Whether book is identified as fiction or not + Whether device is an e-ink e-reader or not + Event k-1 + Event k-2 + Reading session number + Whether device is an e-ink e-reader or not x Reading session number + Event k-1 x Event k-2 + (1 + Event k-1 + Whether device is an e-ink e-reader or not + Event k-2 | Book ID) + (1 + Reading session number | User ID) + (1 | Device ID)
TS TC 2	log(Continuous Engagement Duration in Minutes + 1) ~ Whether device is an e-ink e-reader or not + Event k-1 + Event k-2 + Reading session number + Whether device is an e-ink e-reader or not : Reading session number + Event k-1 : Event k-2 + (1 + Event k-1 + Event k-2 + Whether device is an e-ink e-reader or not | Book ID) + (1 + Reading session number | User ID) + (1 | Device ID)

Note. See Table D7 for the model indicators.

Appendix E

Participant Recruitment Adverts Used in Chapter 5

Participants were recruited via social media i`n the study described in Chapter 5. For this purpose, we created graphics to be used in social media channels created for the purposes of the study. To reach a bigger sample, we reached out to organisations, influencers, librarians, and public figures, asking them to share information about the study. The recruitment call was published in Facebook, Twitter, and Instagram on 31st of August 2021 using the advert shown in Figure E1.

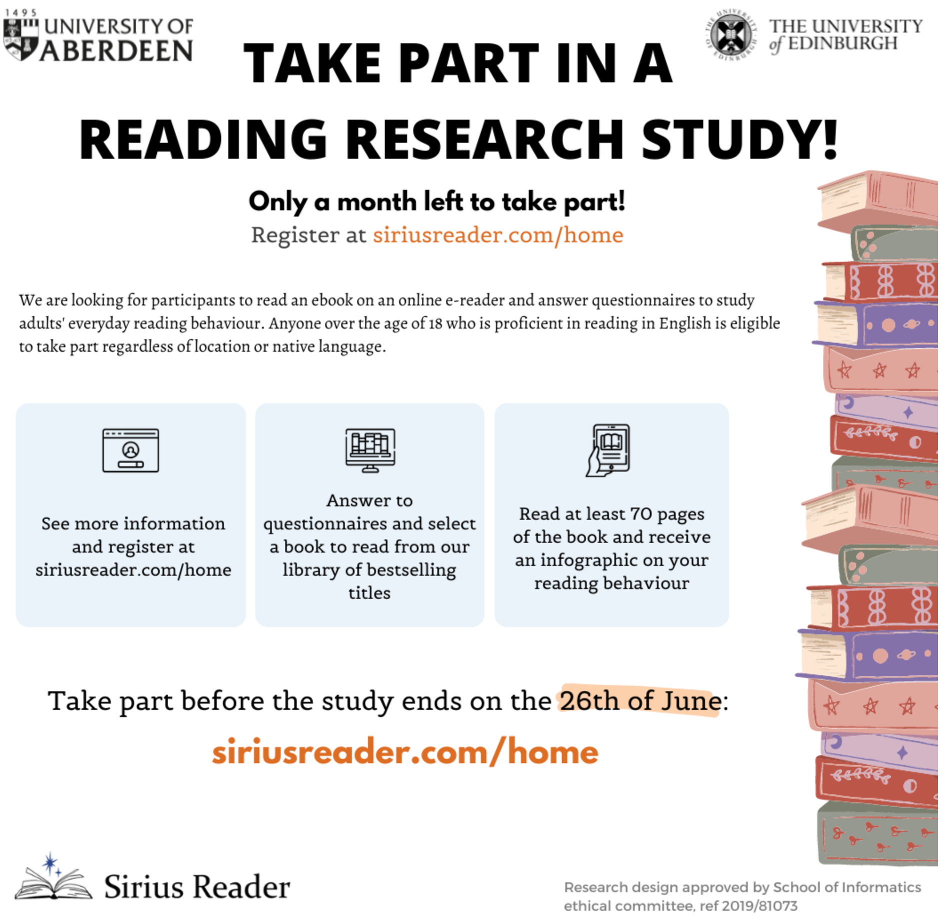
Figure E1

Advert used for recruitment purposes in study 2.

To encourage participation, the social media channels of the study were kept active with biweekly posts throughout the recruitment phase. Another large-scale recruitment push was organised for 26th May 2022, a month before the recruitment phase was brought to an end. The advert used on this occasion is shown in Figure E2.

Figure E2

Second advert used for recruitment purposes in study 2.



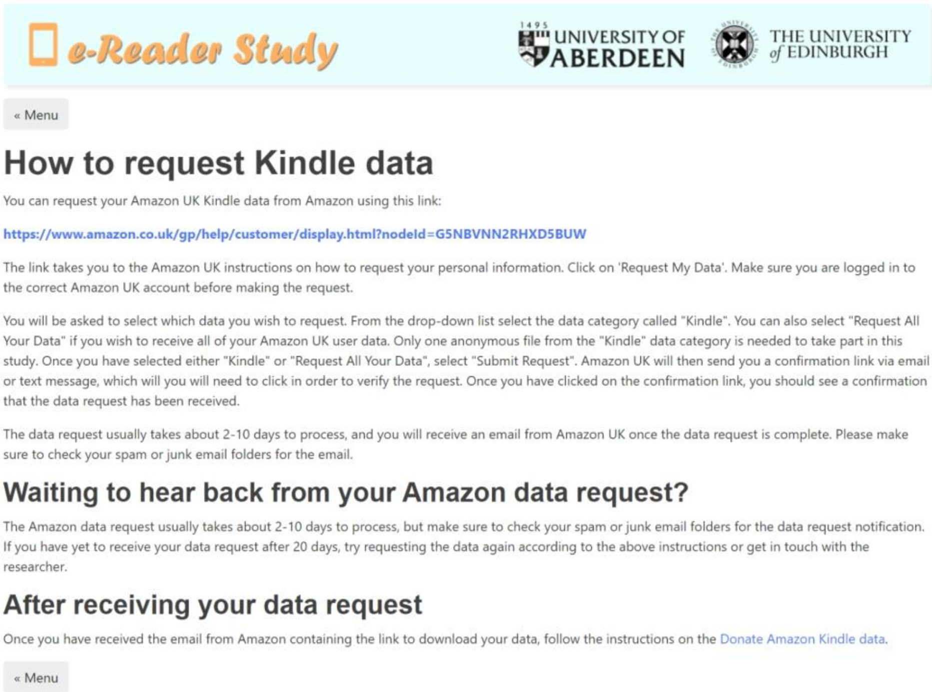
Appendix F

Amazon Kindle User Data Instructions Used in Chapter 6

In Chapter 6, participants were asked to donate a dataset from their Amazon Kindle user data. Figure F1 shows the instructions on how to request the data from Amazon UK, and Figure F2 shows instructions on how to donate the correct dataset.

Figure F1

Instructions Given to Participants on How to Request their Amazon Kindle User Data.



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How to request Kindle data

You can request your Amazon UK Kindle data from Amazon using this link:

https://www.amazon.co.uk/gp/help/customer/display.html?nodeId=G5NBVNN2RHXD5BUW

The link takes you to the Amazon UK instructions on how to request your personal information. Click on 'Request My Data'. Make sure you are logged in to the correct Amazon UK account before making the request.

You will be asked to select which data you wish to request. From the drop-down list select the data category called "Kindle". You can also select "Request All Your Data" if you wish to receive all of your Amazon UK user data. Only one anonymous file from the "Kindle" data category is needed to take part in this study. Once you have selected either "Kindle" or "Request All Your Data", select "Submit Request". Amazon UK will then send you a confirmation link via email or text message, which will you will need to click in order to verify the request. Once you have clicked on the confirmation link, you should see a confirmation that the data request has been received.

The data request usually takes about 2-10 days to process, and you will receive an email from Amazon UK once the data request is complete. Please make sure to check your spam or junk email folders for the email.

Waiting to hear back from your Amazon data request?

The Amazon data request usually takes about 2-10 days to process, but make sure to check your spam or junk email folders for the data request notification. If you have yet to receive your data request after 20 days, try requesting the data again according to the above instructions or get in touch with the researcher.

After receiving your data request

Once you have received the email from Amazon containing the link to download your data, follow the instructions on the Donate Amazon Kindle data.

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Figure F2

Instructions Given to Participants on How to Donate a Dataset from their Amazon Kindle User Data.