Screen Time and Parental Mental Health - Implications on Development in Childhood

by Nghi Hoang Bui

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Doctor of Philosophy

under the supervision of Professor Jane Maguire, Professor Marilyn Cruickshank & Dr John McAloon

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“Disconnect from technology and reconnect with each other.”

- Rose Mary Wixom

Certificate of Original Authorship

I, Nghi Hoang Bui, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Graduate School of Health, at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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Statement of Thesis Format

The present work is in the format of thesis by compilation, including a mix of published and unpublished works, as well as linking text between some chapters. The content of manuscripts of published papers is identical to the published versions.

List of Publications

Study 1 (Chapter 2):

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All authors contributed to the research design of this paper. NHB was responsible for retrieval and analysis of the secondary dataset. NHB prepared the manuscript, which was reviewed and edited by MC and JM_2.

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Paper 3 (Chapter 5): Handheld Devices: The Barrier for Parents with Mental Health Difficulties in Child Outcomes – Published

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Impact of COVID-19 on Research

This project was conducted in part during the COVID-19 pandemic, in particular during the years 2020 and 2021. Because of this, there were some unforeseen challenges that occurred and affected the progress of this project.

The first data collection time point was completed a month earlier than projected due to public health lockdown restrictions imposed during March 2020. During this time, schools were closed and parents might have been limited in their ability to participate in a study. In addition, the second data collection time point was during the latter half of 2020 and earlier part of 2021. During this time, parts of Australia experienced a number of snap lockdowns due to outbreaks. During the pandemic, parents and children were engaging in more device use, for both work and educational purposes, which may have affected the data on screen time. Moreover, parents may have experienced increased stress in response to greater work and parenting responsibilities, and this may have influenced the data on parental mental health. The increased burden and stress of parents may have affected data collection and follow-up rates of the study. Therefore, the results of the thesis have been influenced by this context, and reframed to reflect this during the write-up stage.

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Glossary of Key Terms

Term	Definition
Academic achievement	Any identifiable success in the areas of education or disciplined study.
Anxiety	An emotion characterised by apprehension and somatic symptoms of tension in which an individual anticipates impending danger, catastrophe or misfortune.
Attachment	The emotional bond between a human infant or a young nonhuman animal and its parent figure or caregiver.
Attunement	The matching of affect between infant and parent or caregiver to create emotional synchrony.
Depression	A negative affective state, ranging from unhappiness and discontent to an extreme feeling of sadness, pessimism and despondency that interferes with daily life.
Developmental outcomes	A consequence on the social, emotional and behavioural development including features of child development, such as prosocial skills, emotional expression, self-regulation and hyperactivity.
Externalising problems	A group of emotional and behavioural symptoms that is contained outside of the self. These include aggression, conduct problems, delinquent behaviour, oppositionality, hyperactivity and attention problems.
Handheld devices	A piece of computing equipment that can be used in the hand, such as a smartphone or tablet.
Handheld screen time	The amount of time spent using a device that is used in the hand, such as a smartphone or tablet.
Internalising problems	A group of emotional and behavioural symptoms that refer to processes within the self. These

	include anxious and depressive symptoms, social withdrawal and somatic complaints.
Mental health	A person's condition in relation to their psychological and emotional wellbeing.
National Assessment Program for Literacy and Numeracy (NAPLAN)	A standardised national curriculum assessment undertaken by Australian students in Grade 3, 5, 7 and 9 in numeracy and literacy skills.
Reinforcement	A consequence that follows an operant response that increases (or attempts to increase) the likelihood of that response occurring in the future.
Screen time	Screen time is the amount of time spent using a device with a screen, such as a smartphone, computer, television or video game console.
Sedentary behaviour	Any waking behaviour characterised by an energy expenditure ≤1.5 METs while in a sitting, reclining or lying posture
Stress	A state of mental or emotional strain or tension resulting from adverse or demanding circumstances.
Technoference	The interruptions in interpersonal communication caused by attention paid to personal technological devices.
Traditional screen time	The amount of time spent using older forms of technology such as television, computers or video game consoles.

Abstract

This technological era has witnessed an increasing number of young children engaging in the use of handheld devices such as smartphones, iPads, and tablets; now widely accessible for both recreational and educational purposes. Parents shape screen habits and behaviours in children, and the subsequent effects of this device use on their developmental outcomes are unclear. This thesis aimed to examine: 1) the relationship between parental mental health and other parental characteristics and child screen time (ST), and 2) the effects of ST on the developmental outcomes of children. This thesis is structured around four studies, comprising an analysis of a secondary longitudinal dataset, a systematic review, a cross-sectional study and a longitudinal study. Study one consisted of an analysis of a secondary dataset namely *"Growing Up in Australia: The Longitudinal Study of Australian Children (LSAC)"* (Soloff et al., 2005). This study investigated the temporal effects of television (TV), computer and gaming console use on the academic achievement of children aged 4-5 years on enrolment (N=2954). This study supported previous findings that TV, computer and gaming console use had a negative association with academic achievement across time. Study two was a systematic review of the existing literature in the field. Twenty studies were included in the review, of which 15 studies examined parental characteristics associated with child handheld ST and five studies investigated the effects of screens on developmental outcomes in children. Study three was a cross-sectional study of 214 parents with children aged 4.5-6 years, which examined the relationships between parental mental health, handheld ST and child outcomes. Finally, study four (N=101, M_{age} at T1=5.25, SD_{age}=.44, M_{age} at T2=6.51, SD_{age}=.52) utilised data from the previous study to capture the longitudinal effects of the key variables. Collectively, this thesis identified many parental characteristics that contribute towards children's exposure to screens. In

particular, this thesis was among the first to consider studies that examined specific symptoms of parental mental health in relation to ST. This research found that parents with poorer mental health are more likely to have children who engage in greater ST, as well being more likely to engage in more ST themselves. Overall, these findings can inform policy development and guidelines tailored to parents with poor mental health, where warranted. Future research may consider factors such as screen content, and the context and conditions under which ST is engaged in, rather than just the amount of exposure to ST.

CHAPTER 1: Introduction

Thesis Background

Screen time (ST) has become a dominant pastime norm among young children, and a source of conflict and tension in the family home (The Royal Children's Hospital Melbourne, 2017). It has been well established that the system surrounding a child has a number of implications for a child's developmental trajectory (Bronfenbrenner, 1979). One of the ways in which parenting has changed is the role played by handheld devices. These devices have grown in popularity due to their accessibility, portability, decreasing cost, interactive features and multiple applications (Paudel et al., 2017). Given their portability, parents are now using these devices in everyday family situations and in the presence of their children, including during play, meal and bedtime routines. This poses the risk of parent-child interactions being interrupted and reduced in quality (McDaniel & Coyne, 2016; Wolfers et al., 2020). Specifically, handheld devices have changed the way in which parents and children interact with one another, with screens potentially forming a barrier to the innate attachment processes that occur through live feedback between the parent and child (Oduor et al., 2016; Radesky et al., 2014). Indeed, studies have shown that parents may become less responsive and sensitive to a child's needs when distracted by handheld devices (Ante-Contreras, 2016; Radesky et al., 2014).

At the same time, handheld devices have also enhance skill-learning and play opportunities for children, as well as increasing connections with distant family and friends (Radesky, Schumacher, et al., 2015; Troseth et al., 2016). A systematic review of children aged two to five years of age has shown that tablet devices are associated with improved reading, writing, and vocabulary skills, and problem-solving skills and earlier fine motor development (Herodotou, 2018). Interestingly, this review observed that handheld devices

demonstrate a greater positive effect on academic performance than non-digital books (Masataka, 2014); however, these devices are not as effective as parent-child reading activities (Krcmar & Cingel, 2014). This evidence further supports the theory that parental involvement is crucial to children's learning and development. Previous research has demonstrated that parents play a significant role in driving screen use habits among young children (Duch et al., 2013; Hoyos Cillero & Jago, 2010; Paudel et al., 2017). These systematic reviews have collectively outlined parental characteristics that are associated with child ST, such as parental ST, attitudes towards ST, regulatory practice and limit-setting, maternal depression and parenting style (Duch et al., 2013; Hoyos Cillero & Jago, 2010; Paudel et al., 2017).

While parents play a key role in their child's development, their own mental health has been underexplored in the context of handheld ST. Research has suggested that parents with mental health difficulties may struggle to effectively support and monitor their child (Borre & Kliewer, 2014; Bronte-Tinkew et al., 2007; Pape & Collins, 2011). More specifically, parents with mental health difficulties tend to have a lower tolerance for responding to their child's misbehaviour or emotional distress (Oyserman et al., 2005). Therefore, parents with poor mental health may engage with handheld devices to give themselves a break from the competing demands of parenting and managing their own mental health, as well as to keep their children occupied. Given that handheld devices may act as a barrier to parent-child interactions, this situation may have greater implications and more serious outcomes for the child when a parent has mental health difficulties.

Since parental characteristics contribute to child ST, it is also worthwhile to investigate the implications of such devices for child development. Children are engaging with these devices in sensitive developmental periods, when they are highly receptive to stimuli in the external world (Woodard & Pollak, 2020). This can influence their social

interactions with family and peers, as well as their emotion regulation, behaviour, academic performance and adaptive functioning (Genc, 2014; Varni et al., 2014; Wu et al., 2017). The existing literature is focused heavily on physical developmental outcomes, meaning that further research on children's social, emotional and behavioural developmental outcomes is warranted. Moreover, it is important to consider how ST can be utilised and moderated by parents to maximise its benefits and shape a healthy trajectory for their children.

This chapter introduces the current evidence base and sets the context by providing background information regarding children's screen use and broader theories related to screen use. The research problem and research questions are stated, followed by the aim and objectives, and the anticipated contributions of this present research.

Thesis Outline

This thesis consists of seven chapters. In this thesis:

- Chapter 1 outlines the background literature review of the underlying evidence base and theories of the research. This chapter also provides the aims and questions of the present research, as well as its anticipated contributions.
- Chapter 2 is a longitudinal study conducted to examine the effects of traditional ST on academic achievement in five domains: reading, writing, numeracy, spelling and grammar/punctuation. This research was conducted based on evidence from the last 12 years. This study, which mirrors the period over which handheld devices started to become popular, utilised secondary datasets to inform the temporal effects of traditional forms of ST.
- Chapter 3 is a systematic review conducted on evidence from the last 10 years to identify: a) parental characteristics associated with child handheld ST, and b) the social, emotional and behavioural effects of handheld ST on child developmental outcomes.

- Chapter 4 provides a brief summary of the key findings from the systematic review and outlines discussion of the context for the upcoming studies.
- Chapter 5 describes a cross-sectional study conducted to investigate the relationship between parental mental health, handheld ST and child developmental outcomes, such as internalising and externalising symptoms, and to examine whether handheld ST mediates the relationship between parental mental health and child developmental outcomes.
- Chapter 6 is a longitudinal study conducted to explore the relationship between parental characteristics, handheld ST and the implications for child developmental outcomes, and to investigate changes in the developmental trajectory as children enter and begin formal schooling.
- Chapter 7 presents a general discussion of the results of each of the original studies in the context of current evidence, as well as the theoretical and clinical implications of the present research. This chapter also addresses the general limitations and strengths of the present research. Lastly, this chapter outlines the future directions of research and conclusions of the findings.

Child Screen Use: An Overview

Over the past decade, our lives have become increasingly technology-saturated, particularly with the rise of newer and portable forms of screens. ST is defined as engagement with electronic media, either using traditional platforms (e.g. TV, gaming consoles and computers) or handheld devices (e.g. smartphones, tablets, iPads, iPod Touches, Kindles, ebook readers or similar; Rideout, 2013). Screen devices serves to function a wide variety of activities such as social networking, learning, creativity, self-expression, playing games and entertainment (Yu & Baxter, 2016). However, handheld devices have increased the access, portability and multifunctionality of screens in comparison to TV and computers which can only be accessed in one setting. Traditional forms of ST, such as TV and

computers, have existed since the 20th Century. They remain the most popular form of ST, with approximately 60% of American children aged 0-8 years of age watchTV at least once a day, and 14% use computers daily (Rideout, 2013). Findings from an Australian study by Jordan et al. (2006) of children aged 4-12 years revealed that on average, families had four TV sets in the home which include the living room (98%), followed by the parent's bedroom (77%), the child's bedroom (63%) and an eating space such as the kitchen or dining table (46%). In terms of content, educational TV referring to media designed to increase school readiness was the most popular genre, with around 61% of American parents zero to eight-year-olds reporting that their children either often or sometimes watched educational shows. Another 52% watched children's entertainment shows frequently, and 11% watched "general audience" shows (e.g. *Modern Family*, *American Idol*). In particular, older children in this age group tended to watch children's entertainment shows, whereas younger children were more likely to watch educational TV (Rideout, 2013). Children's TV programs that were educational, maintained children's interest and were interactive in nature were more beneficial for learning and development (Biggins et al., 2011; Wainright, 2006).

An Australian study of children aged 0-15 years found that the majority of families (94%) imposed rules for TV viewing (Australian Communications and Media Authority, 2015). The most common rules relate to the type of programs, the channels viewed, the time spent viewing, and the time of day children view TV. These findings showed that parents rely on their rules in order to control and moderate what their children are viewing on TV (Australian Communications and Media Authority, 2015). More specifically, parents of Chinese background with primary school-aged children set rules about content and viewing time, with some parents allowing children to watch TV only after completing their homework, and others concerned about inappropriate TV advertisements (Chan & McNeal, 2003). This study suggested that cultural factors may underlie differences in children's ST;

however, the majority of the research has been sampled from families with Western backgrounds. Jordan et al. (2006) conducted a study of Australian children aged 4-12 years and found that 41% of children are set no rules regarding time spent watching TV, and a similar proportion have the TV on during dinnertime. Around 63% live in a family where there is a TV in at least one of the children's bedrooms (Jordan et al., 2006). This was similarly represented in a Portuguese sample, where around 50% of children had a TV in the bedroom, and this was associated with greater TV viewing (Jago et al., 2012). TV has remained a constant presence in the family home, where the rules set by parents and its presence in bedrooms may increase its use by children.

Studies have shown that many children have access to a computer and video consoles; however, computer and console use is lower than TV use (Li et al., 2007; Oka et al., 2008). Approximately 94% of American children aged 3-18 have access to a computer at home, and this is more common among older children and children with parents with higher levels of educational attainment and higher socioeconomic status (SES; U.S. Department of Education, 2018). These statistics are similar to those from a Hong Kong sample of preschool children, which found 70-90% using a computer at home or at school (Census and Statistics Department, 2013). Greater mobile dexterity and manipulation are required for computer use, which may partly explain the higher engagement among older children (Rideout, 2013). With console use, around two-thirds of American children aged up to eight years have access to a console player at home, and one-third have access to a handheld game player (e.g. Game Boy, PSP or Nintendo DS; Rideout, 2013). Parents have reported that most American children are not playing educational games, with only 4% often playing educational games (Rideout, 2013). While computers and gaming consoles have changed the technology landscape by providing more interactive forms of ST, TV appears to be still the preferred device for ST.

As technology has continued to develop, researchers have found that handheld device use is starting at a younger age. Most parents allow their children to start using these devices in the first year of life, and by age two most children are using them on a daily basis (Kabali et al., 2015). In an Australian survey, the majority of parents reported that their child spent at least three hours on screen-based devices at home on an average day (Rhodes, 2017). With the advent of iPads and tablets, introduced in 2010, and of iPhones and similar smartphones from 2007, handheld devices have quickly become a widespread phenomenon (Apple, 2010; Pressman, 2010). By the end of 2009, approximately one in seven smartphones sold worldwide was an iPhone (Pressman, 2010). At the end of 2018, it was predicted that Apple was poised to sell its two billionth iOS device (Owen, 2018). Countering the popularity of Apple's iPhone and iOS system, Google introduced an alternative mobile operating system, Android. In 2010, more Android-based phones than iPhones were sold (Pressman, 2010). Given the prevalence of handheld devices, more and more children are accessing and using their own personal devices.

Research has shown that handheld devices are widely used by young children. Recent evidence suggests that approximately 36% of Australian preschoolers own a handheld device, and this figure doubles for primary school-aged children (Rhodes, 2017). Smartphones are used more than tablets by American children aged zero to eight (Rideout, 2013). Genc (2014) found that even toddlers are able to confidently manipulate smartphones and tablet devices. In parallel with the most popular TV content, educational games are the most popular applications on handheld devices, followed by entertainment apps and creative apps (e.g. drawing, music, photos). Given these rapid technological changes, it is worthwhile to explore the implications of use of handheld devices and to ascertain whether findings from this use mirror those of use of traditional forms of screens.

The advent of handheld devices has seen a switch from traditional forms of ST to digital ST consumption. In 2013, children spent less time watching TV (65%) than in 2011 (58%). By contrast, they spent more time on handheld devices (72%), such as smartphones and tablets, than in 2011 (38%; Rideout, 2013). Access to handheld devices rose substantially between 2011-13, with almost as many children as parents by then owning a tablet (Rideout, 2013). Children can now access screens across multiple contexts and can also carry their devices with them in their daily lives, which was not possible with TV and computers. Children also have greater opportunities to access a range of digital media in the home, where they can stream TV, browse the internet, play games, and engage in other types of screen-based activities (Lauricella et al., 2015). Furthermore, a generational gap relating to technology use and understanding has arisen between parents and children. Specifically, children have become advanced in their knowledge and use of handheld devices, while parents are regulating and using devices about which they are less knowledgeable than their children. Given the ever more rapid pace of changes in modern technology, it is important to consider whether the effects of handheld ST on children are similar to or different from those of traditional screens.

Guidelines for Screen Time

With the increasing role of ST in children's lives, policies and guidelines developed by health experts have been established, relating to setting limits on child ST (American Academy of Pediatrics, 2016a). The American Academy of Pediatrics (2016b, 2016c) has released two policy statements that recommend that children aged two to five spend no more than an average of one hour per day on screens, and older children no more than two hours per day. These guidelines were developed for paediatricians, families and the wider community to address the public's concerns about ST. They are also intended to meet the individual needs of families, enabling them to produce a Family Media Use plan that takes

into account the developmental stage of each child (American Academy of Pediatrics, 2016c). The American Academy of Pediatrics (2016b, 2016c) policy statements recommend guidelines for parents on ST that cover: consistent limits on ST for children under six, limiting access to screens in children's bedrooms, ongoing communication about screen use, monitoring how screens are used, co-using screens to help children understand the content viewed, and acting as role models by limiting their own ST. They address different health and developmental concerns, such as obesity, sleep, parental contributions, mental health and child development (American Academy of Pediatrics, 2016b, 2016c). However, these guidelines are based on research conducted in America, which limits their usability for parents from non-Western backgrounds. Nevertheless, guidelines on healthy screen practices for children require parents to remain informed and up-to-date as technology continues to evolve.

Australian guidelines were developed based on the Canadian 24-Hour Movement guidelines (Tremblay, 2020), and are similar to those from the American Academy of Pediatrics (2016a). In addition to the exposure limits and other ST rules mentioned above, the Australian guidelines recommend that children under five should be viewing only educational content (Department of Health, 2021). They recommend that all children be rewarded for desirable behaviour with active family time, rather than ST, and be set allocated time periods to be on screens, as well as having their bedrooms kept screen-free (Department of Health, 2014, 2021). These guidelines, though, are aimed at the average population of parents and are not tailored towards more vulnerable populations, such as parents with mental health problems, who may face challenges implementing such practices. In addition, researchers have raised concerns of the feasibility of parents from low SES backgrounds to implement such guidelines. Specific guidelines for this subgroup of parents do not currently exist,

however it has been argued knowledge translation tools may be a way to address this issue (Tremblay et al., 2017).

Blum-Ross and Livingstone (2018) critiqued the current guidelines of the American Academy of Pediatrics. They noted that the guidelines are based on available evidence which represented some methodological concerns and that they are difficult to apply to the practical realities of family life. For example, there are key differences in relation to the types of screens investigated, as well as to whether ST was for recreational or educational purposes. Therefore, it is difficult for findings to be merged. There are also several confounding factors that may contribute to children's development, of which researchers can control for only a number. For example, children who are overweight may prefer to engage in ST. The various guidelines are also largely based on correlational evidence, and it is therefore difficult to draw casual inferences from findings (Blum-Ross & Livingstone, 2018).

Interestingly, Blum-Ross and Livingstone (2018) raise the concern that simple time limits on screen use may no longer be effective, particularly since ST can encompass homework, learning about the world, time with friends or video calls with family. Research has established that when parents co-view and engage with their children in ST, through asking questions and extending play, this may lead to more beneficial outcomes for children (Strouse et al., 2013). In fact, it is suggested, guidelines should be focused on helping families to understand the content of what children are viewing and interacting with on screens, as well the context of children's ST, and the connections they make while watching and interacting with screens (Blum-Ross & Livingstone, 2018). Consideration of these factors, and of the involvement of parents, rather than considering only the amount of screen exposure, will provide a richer insight into the consequences of screen use for children's outcomes.

Interestingly, researchers have found that the majority of children exceed the recommended two-hour daily limit for ST in a number of countries, including Australia, America, Belgium, the Netherlands, Norway and Slovenia (Brug et al., 2012; Houghton et al., 2015; Hume et al., 2019; Kristiansen et al., 2013; Thomas et al., 2020). An Australian study of children aged up to 12 years found that the age group that exceeds the recommended guidelines for daily ST is children aged 1-4 years (Tooth et al., 2019). Moreover, a longitudinal report on young Australian children found that, at 4-5 years old, children engage in over two hours of ST per weekday, and by 12-13 years old this increases to more than three hours per weekday and up to four hours per weekend day (Yu & Baxter, 2016). However, this data and subsequent guidelines is largely based on parent self-report and therefore is subjected to recall or social desirability bias. Objective ways of measuring ST in conjunction with self-report day may increase the reliability and validity of findings and therefore strengthen evidence for current guidelines.

A recent systematic review of 622 studies evaluated the measurement tools of ST used in studies of children aged 0-6 years old (Byrne et al., 2021). It was raised that most measures assessed duration, where only few examined content (11%). In addition, only 11% of studies commented on psychometric properties, however those that did report on these found psychometrics to be generally above acceptable thresholds. It is also worth noting that screen habits formed in early childhood are highly changeable, in contrast to those adopted later in life (Hamilton et al., 2016), and this represents a growing area for preventative measures. With the increased use of handheld devices, there is great interest in understanding more about the appropriate threshold and context for adaptive and safe ST, the characteristics associated with greater ST, and the benefits and risks of children's ST.

Factors related to Screen Time

The identification of factors related to ST provides a richer context for the current patterns and trends of ST, as well as targets for intervention. Numerous demographic factors are associated with child ST, including gender, age and SES. While several studies have concluded that boys are more likely than girls to surpass the daily limit of two hours of ST (Carlson & Berger, 2013; Hardy et al., 2006; Hesketh et al., 2007). Houghton et al. (2015) and Downing et al. (2017) found that girls engaged in more ST than boys. Lending strengths to these findings, Houghton et al. (2015) considered participants' SES backgrounds, and Hesketh et al. (2007) utilised a prospective design, meaning that causality could be inferred. These studies attributed that the gender-related differences may be due to the type of screen-based activities in which boys and girls engage, and to how ST is measured among studies. For example, boys are more likely than girls to spend time gaming on handheld devices, while girls are more likely to use devices for social networking (Houghton et al., 2015). The research base is inconsistent for gender differences relating to ST, and therein lies an area for further investigation.

Early intervention is crucial for addressing screen habits, as longitudinal studies have found that ST tends to increase with age. In particular, a systematic review revealed that ST tends to increase from early childhood to early adolescence, where those that were "high users" at young ages tend to remain high users when older (Marshall et al., 2006). The challenge with this review, and among several other studies, is that recall periods may vary between studies with some asking for behaviours ranging from the past evening, one or seven days, and even 10 or more days. It is suggested that shorter recall periods provide more valid estimates of behaviour (Marshall et al., 2006). However, given that technology is rapidly changing, the field could benefit from more updated longitudinal studies. For example, a longitudinal study focusing on TV viewing and computer and electronic gaming use found

that approximately 44% of Australian children aged 4-5 spend more than two hours on screen-based activities, but this proportion decreases to 25% at 6-7 years. However, it increases during every subsequent two years, with around 64% of children aged 12-13 spending over two hours on ST on weekdays (Yu & Baxter, 2016). The statistics are higher for ST on weekends, when children aged four to seven spend around 2.5 hours per day on screens. Additionally, more than 50% of children aged 4-5 exceed the daily limit on weekends, and this proportion increases to 77% for ages 10-11 and 12-13 (Yu & Baxter, 2016). TV watching remains a relatively stable behaviour from childhood to adulthood (McVeigh et al., 2016). Early exposure to screens increases the likelihood of overuse of devices in later life, and tends to involve recreational rather than educational viewing (Canadian Paediatric Society, 2017). With an increasing number of children exceeding the recommended limit, it is all the more essential to consider the factors that may stimulate such overuse, and to intervene at an early stage when habits are easier to mould than in adolescence and adulthood.

Although there is a strong evidence base for the increased use of traditional forms of ST, researchers have questioned whether this applies to newer and portable forms of screens. Existing systematic reviews have explored handheld ST in children (Duch et al., 2013; Hoyos Cillero & Jago, 2010; Paudel et al., 2017). The review by Paudel et al. (2017) investigated children between 0-8 years of age and Hoyos Cillero and Jago (2010) examined those seven and under, whilst Duch et al. (2013) specifically focused on infants and toddlers namely children three and younger. Paudel et al. (2017) found a positive association between a child's age and handheld ST in 75% of the studies, with older children more likely than younger children to use handheld devices. This finding was consistent with Duch et al. (2013) and Hoyos Cillero and Jago (2010) who solely reported on traditional forms of ST. This could be due to wider access to/ownership of devices, decreased parental limits and rules, and

increased skills (e.g. dexterity) as children age (Paudel et al., 2017). While age and gender differences have been explored, other factors in the family environment may exacerbate handheld device use in childhood.

Research has indicated that SES has an inverse relationship with children's ST, with a higher SES associated with less ST. In particular, parental education has been shown to be a strong predictor of children's ST, while increased TV and computer use has been found in children with less educated parents (Brug et al., 2012; De Craemer et al., 2018). This is supported by a longitudinal study of adolescents which considered the additional predictor of neighbourhood SES (Brodersen et al., 2007). The findings may be partly due to parents with higher education tend to set limits on ST, based on their understanding of the effects of digital media use (De Craemer et al., 2018). Moreover, lower levels of parental education are associated with lower levels of parental modelling and less parental co-viewing (Gebremariam et al., 2015). In contrast, Hinkley et al. (2013) suggested that children exceeding ST guidelines are equally distributed among different SES groups, and recommended that public health policies be directed to all children rather than specific demographic groups. As parental oversight of ST habits may differ across SES, this may suggest that parental factors partly account for child ST.

Within the last decade, handheld screen devices have become more available, more accessible and more widely used among young children (Kabali et al., 2015). The portability of handheld screens means that they are able to be used across multiple contexts – at home, at school, during extracurricular activities – thus further increasing their frequency of use. It appears that child ST may be more prevalent in boys than girls, increases with age, and is negatively associated with SES. But given the conflicting evidence among the findings, it is important to consider other factors relating to child ST, such as the system around children – particularly parental influences – that may shape children's ST.

The Family System in Children's Screen Time

Parents play one of the most significant roles in influencing children's activities and lifestyles, especially during the critical developmental years namely the first five years of life (Sheridan et al., 2008). Evidence from systematic reviews has suggested that lifestyle interventions for children are often more successful when parents are involved (McLean et al., 2003; Niemeier et al., 2012). Given the role that parents play in their children's lives, a number of theories explain how parents contribute to a child's ST, and the resulting impact on a child's developmental trajectory. These theories are: 1) bioecological theory, 2) attachment theory, 3) social learning theory, 4) operant conditioning principles, and 5) coercive family processes. Bioecological and attachment theory provides the foundation to the parent-child relationship, and addresses how screen time may influence this relationship. Whereas, social learning theory, operant conditioning principles and family coercive processes explain the mechanisms as to how screen time is increased/decreased or regulated by parents.

Bioecological Theory

Bioecological theory proposes that child development is facilitated by a number of concentric environmental systems: the microsystem, mesosystem, exosystem and macrosystem (Bronfenbrenner, 1979). The microsystem is the immediate environment in which the child lives and thus has the biggest influence on a child. It includes the child's immediate relationships and the organisations with which the child interacts, such as family, peers and school. The mesosystem focuses on the inter-relationships between various microsystems. For instance, children's academic performance may be influenced by parental involvement in their schooling as well as children placing value on their academics. The exosystem describes the indirect effect on an individual's developmental outcomes, and is the setting in which the child is not actively involved, such as the parents' workplace. Stressors

in the workplace may affect how parents interact with their children. Finally, the macrosystem considers the wider community and culture, as well as the socioeconomic conditions of the family (Ashiabi & O'Neal, 2015; Bronfenbrenner, 1976).

A systematic review by Duch et al. (2013) used this framework to investigate correlates of ST within these systems. However, this review showed mixed results and pertained only to traditional forms of ST. The review ascertained that greater ST was associated with increased maternal ST and maternal depression, as well as with decreased cognitive stimulation in the home. However, it found no association between a child's gender or the presence of siblings and ST, and an unclear association with maternal education. These mixed findings were similar to another review that examined traditional ST, conducted by Hinkley et al. (2010). However, a study by Lauricella et al. (2015) proposed that the family system has the most direct influence on child development, given its presence, frequency and significance for the child. Lauricella et al. (2015) further added that children were constantly exposed to parental screen behaviours and their interaction with these devices in the home. Interestingly, Tooth et al. (2021) noted that family contextual factors have not typically been considered in research relating to ST and children's developmental outcomes. Tooth et al. (2021) sought to consider these variables and demonstrated that higher levels of family ST are associated with poorer total behaviours (e.g. conduct problems, emotional symptoms, hyperactivity/inattention, peer problems) and prosocial behaviour. A strength of this study is that it specifically examined recreational ST and had a broadly representative sample of Australian children from age two to 12. This suggests that a better and more consistent understanding of the parental characteristics associated with child ST, as well as of general family context, is needed to clarify the implications of screens for children's development

Attachment Theory

Attachment refers to the emotional bond formed between a child and their primary caregiver (Keller, 2018). This emotional bond should lead to a feeling of security or trust that an infant develops in themselves (Keller, 2018). Parent-child interactions are characterised by high parental sensitivity and responsiveness, which determine whether an infant will acknowledge the caregiver as a secure base and thus develop a secure attachment (Kildare & Middlemiss, 2017). Bowlby (1969) proposed that individuals gradually form expectations about the availability and responsiveness of attachment figures. These expectations are based on their responses to early experiences with their caregiver, which become integrated into their internal working models (Bowlby, 1969). These internal working models lay the groundwork for a child's development, especially in relation to how they respond to distressing situations and cope with support from others (Gormley, 2005; Sroufe & Waters, 1977). Over time, internal working models become stable and generalised, providing the basis for motivating patterns of thought, affect and behaviour about the self, others and the world (Rholes et al., 2007).

Building on Bowlby's internal working models framework, researchers have proposed that the role of attachment may predominately focus on the way children respond to sources of threat or challenge, and the extent to which they are able to rely on parental support and comfort as a means of coping (Kobak et al., 2015). For example, children with secure attachments have had consistent experiences of their parent being responsive when support and proximity are needed, and they can depend on their parent to be available when comfort is requested. By contrast, insecurely attached children have most likely experienced rejection and inconsistent responses, and have had their bids for proximity ignored or dismissed (Fearon et al., 2010). Longitudinal findings have demonstrated that early caregiving experiences have enduring effects on adolescent attachment, and this is independent of

current caregiving relationships (O'Connor et al., 2019). This indicates that attachment processes have more fundamental importance during childhood than during adolescence, and have substantial effects on children's development.

Attunement is an essential part of a secure attachment between the parent and child. Attunement defines a process where the caregiver mirrors the emotional expression of the infant in its shape, strength and duration (Haft & Slade, 1989). The dyad between a caregiver and an infant functions in a co-regulated state, where one member relies on the other to identify, reciprocate and expand on their actions (Ostlund et al., 2017). This is necessary for emotion regulation, communicating empathy and emotional availability from the parent to the child. The Still-Face paradigm demonstrates that when a non-attuned caregiver (i.e. one who ceases interaction and maintains a neutral expression) responds to an infant, the infant is more likely to disengage from their caregiver and decrease bidding (Ekas et al., 2013). Bidding refers to attempts at social interaction with the caregiver, such as gazing at the caregiver's face while smiling (Ekas et al., 2013). These changes in infant behaviour have been shown to be associated with issues with infant attachment, infant internalising problems and difficulties with self-regulation (Ekas et al., 2013; Melinder et al., 2010). Essentially, the child's emotional development is shaped by the early caregiving relationship (Ostlund et al., 2017). These findings demonstrate the importance of a parent's responsiveness and sensitivity to interactions with their child.

Interestingly, research has shown that parental ST displaces the quantity and quality of parent-child interaction, and thus affects the attachment bonds. Background TV has been associated with decreased responsiveness of parents to their children, as parents are often distracted by the noise or have difficulty sustaining attention on their child (Kirkorian et al., 2009). In this study, when interactions occurred, they were often of a passive nature. For example, parents might verbally acknowledge the child, but they did not maintain eye contact

or engage with the child enthusiastically (Kirkorian et al., 2009). Moreover, the noise of background TV may act as a barrier to parent-child communication and result in less verbal communication (Kirkorian et al., 2009; Napier, 2014). These findings support the Still-Face paradigm and highlight the importance of attunement in parent-child interactions. By contrast, when parents co-view TV with their child, this has been shown to result in increased quality of parent-child interaction and further benefits for children's social development (Connell et al., 2015; Radesky et al., 2014). This evidence indicates that parental monitoring of child ST can mitigate the risk that child ST can result in poor parent-child interactions. Findings of studies on traditional forms of ST such as TV may be translatable to the context of handheld devices, with these also acting as a barrier to communication if not appropriately used.

There is a growing body of evidence investigating handheld device use and its links to parent-child interaction, and linking it to a mechanism called technoference. Technoference is defined as everyday disruptions to parent-child interactions due to use of digital and handheld devices (McDaniel & Radesky, 2018). Parents reported experiencing technoference both due to their own and their child's screen use, and this was evident in both a US (McDaniel & Radesky, 2018) and Swedish population (Sundqvist et al., 2020). Kildare and Middlemiss (2017) reported that parents using these devices tend to be less attentive, sensitive and responsive to their children. This may precipitate children to engage in disruptive behaviours in order to gain parental attention, or they may not develop enough support to self-regulate. In fact, Stockdale et al. (2020) utilised a modified Still-Face paradigm to investigate the effects of technoference in children aged below one year. These results show that when mothers were unresponsive to their infants due to screen use, infants showed greater negative affect, less positive affect, less parent orientation and escape behaviours (i.e. arching, pulling on highchair restraints, leaning forward). Parents exhibiting technoference tend to be easily

absorbed and influenced by handheld devices, and spend less time engaging in screen-free family activities, such as going outdoors and visiting places, and having parent-child conversations (Wong et al., 2020). The lack of attention and response from parents may result in children being left alone, and them then further engaging with devices for extended periods while their parent is distracted (Wong et al., 2020).

A number of studies have established that parental distraction by handheld devices has consequences for children and their relationship with parents. One study has shown that 35% of adults frequently use their phone while playing with their child (Qualcomm, 2013). Research has observed parents using their device at least three times a day while directly supervising their children (Ante-Contreras, 2016). A recent study demonstrated that technoference mediates the association between excessive parental ST and child psychosocial difficulties. This suggests that reducing parental use of devices when parents spend time with their child may have benefits for a child's psychosocial development (Wong et al., 2020). An observational study of parents and children at fast food restaurants observed that parents were showing less caregiver absorption (i.e. responding to child rather than device) while using devices during mealtimes (Radesky et al., 2014). This study also found that parents demonstrating high caregiver absorption were more likely to respond harshly to child misbehaviour (Radesky et al., 2014). These findings were limited to a Western sample from metropolitan areas, which is a common limitation across studies in this field. With the increasing prevalence of handheld devices, the implications of disruptions to parent-child interactions are a worthwhile area to explore, especially in relation to both parental and child ST.

Research has found that when parents are engaged with a device, children have to compete for their attention (Oduor et al., 2016; Radesky et al., 2014). Recent studies have demonstrated that parents who use smartphones for longer periods have lower sensitivity

towards their child (Braune-Krickau et al., 2021; Wolfers et al., 2020). This may be due to such devices inducing a deeper absorption than other forms of distraction and hence making it challenging for parents to divide their attention between the device and the child. Braune-Krickau et al. (2021) identified a limitation in the literature, which is that, given that most parents own a handheld device, it is difficult to establish a control group to compare the behavioural differences of users vs. non-users. Parents who are technologically distracted are not only limited in their responsiveness and sensitivity to their child, but are also slower to respond to their child's re-engagement attempts (Oduor et al., 2016; Radesky et al., 2014). For example, in this study, when children attempted to recapture their parents' attention, some parents tried to ignore them before eventually responding, while others scolded their children without even looking up from their devices. Other parents responded physically, kicking their child's foot under the table or pushing them away (Radesky et al., 2014). Moreover, a study with a structured interaction task, involving the introduction of foods to a child, demonstrated fewer mother-child interactions for mothers who used mobile devices (Radesky, Miller, et al., 2015). In line with attunement processes, distractions by handheld devices may form a potential barrier to children having quality interactions with their parents. Exploring the factors underpinning parental use of screens is therefore an area of interest for further study.

Social Learning Theory

Social Learning Theory is based on the underlying principle that learning occurs as a result of observation and imitation of others' actions (Bandura, 1977). Bandura (1977) posited that through observation of others, we develop ideas about how new behaviours are performed. This information is coded and stored into our memory, acting as a guide for action immediately after the observation or for use on later occasions (Bandura, 1977).

Humans will imitate the observed behaviour in order to gain rewards or avoid consequences (Bandura, 1977), which forms the basis for observational learning.

Bandura (1977) stated that four key processes must occur in order for observational learning to take place: attention, retention, reproduction and motivation. Attention is defined as the ability of the observer to pay attention to the modelled behaviour. Retention is based on the ability of the observer to remember the modelled behaviour. Reproduction refers to the observer translating the modelled behaviour into their own appropriate individual actions. As the observer practises this behaviour, their reproduction of it improves. Lastly, motivation means the observer having a reason or purpose for imitating the modelled behaviour (Bandura, 1977).

Particularly during their early years, young children spend a large amount of time observing and learning from their parents and siblings in the home environment (Lauricella et al., 2015). Consistent with social learning theory, children who observe parents engaging with screens across multiple contexts and devices may learn and imitate such modelled behaviour. Evidence from traditional forms of ST has demonstrated such findings, with increased maternal TV use associated with increased child TV use in a Portuguese sample (Jago et al., 2012). In addition, these researchers considered number of years of education, height and weight of child, as confounders. This study also highlighted that especially among younger children, access to screens was associated with higher levels of ST. Studies with handheld devices support previous findings, with parental smartphone and tablet use associated with greater child handheld ST (Lauricella et al., 2015). Therefore, parental ST is closely associated with child ST, which appears to be shaped by learning and imitating the behaviour in the home.

Parental ST is associated with attitudes towards ST, another strong predictor of child ST. Lauricella et al. (2015) demonstrated that parents who view the impact of technology more positively are likely to have children who engage in greater ST. Parents reported various positive attitudes towards ST that encouraged its use among children. These included: screens acting as a "babysitter", development of computer skills useful in later development, use of screens as a regulatory tool of desired behaviour, and their educational value (De Decker et al., 2012; Hesketh et al., 2012; Jordan et al., 2006; Lindsay et al., 2009). In particular, the "babysitter" role of ST is a motivating factor for parents endorsing ST among children. Parents who are stressed or tired from the day are more likely to utilise TV and computers to distract their children while they attend to their errands or have time to themselves (Hesketh et al., 2012). Parental attitudes also affect ST rules for children, with Lauricella et al. (2015) suggesting that parents with more negative attitudes towards ST are more likely to enforce rules or regulate use. As younger children, especially under the age of eight, are heavily influenced by parental rules, this may affect the rate and frequency with which they engage with screens (Lauricella et al., 2015). In sum, child ST is largely influenced by parents' own ST habits, and thus parents with more positive attitudes towards screens are more likely to model such behaviours.

Operant Conditioning

Operant conditioning was first coined by Skinner (1953), a learning theorist, who posited that the frequency of behaviour is controlled by its consequences. Reinforcers act to increase the frequency of behaviour, whereas punishers act to decrease the frequency of behaviour (Murphy & Lupfer, 2014). There are four types of consequences in operant conditioning.

Positive Reinforcement. In this instance, the frequency of behaviour is increased by adding a stimulus (i.e. reward; Murphy & Lupfer, 2014). For example, Skinner (1938)

discovered that when a rat was given a food pellet each time a lever was pressed, the rate of pressing increased. Thus, the food pellet acted as a positive reinforcer. In parenting, children may be rewarded with attention, quality time or praise as positive reinforcers by their parents to increase desirable behaviour.

Negative Reinforcement. Similarly to positive reinforcement, negative reinforcement is based on the premise that a behaviour will be increased if a response or a presentation of a stimulus is removed (Murphy & Lupfer, 2014). For example, this was shown when rats were given an electric shock which caused discomfort (Miller, 2006; Skinner, 1938). When the rats pressed the lever, the response of the electric shock did not occur, leading the rats to repeat this action. Skinner (1953) also found that when rats were shown how to avoid a shock which occurred when a light turned on, they quickly learnt to press the lever when the light came on in order to avoid the shock response. In applied settings, when a child throws a tantrum in a supermarket, the parent may give in to the child's demands in order to stop the unpleasant behaviour. However, this negatively reinforces the phenomenon of the parent giving into the child's demands.

Positive Punishment. This is defined as decreasing the frequency of behaviour through the addition of a stimulus or response (Murphy & Lupfer, 2014). For instance, when a rat learns that each time it presses a lever, it receives a shock, it quickly learns that the shock serves as a positive punisher (Skinner, 1938). Therefore, the rat is less likely to press the lever in the future. Similarly, parents may give their child additional chores if they do not complete their homework, with the chores acting as a positive punisher.

Negative Punishment. By contrast, this means the removal of a stimulus, thus decreasing the rate of a behaviour occurring (Murphy & Lupfer, 2014). In this case, a food-deprived rat may be given unlimited access to food, but learns that pressing the lever may

remove the food (Skinner, 1938). The food removal acts as a negative punisher, as it decreases the behaviour of lever pressing. In parenting, time out is often used to decrease the frequency of undesirable behaviour (e.g. tantrums), with children moved from a stimulating to a dull environment.

Operant conditioning principles explain the mechanisms by which behaviour is learnt and shaped, with some responses encouraged more than others. A number of parenting programs have utilised reinforcement strategies to address child emotional and behavioural difficulties (Dadds & Hawes, 2006; Kazdin, 2008; Turner & Sanders, 2006), and have been shown to be efficacious as reported by a meta-analysis of 24 studies investigating the efficacy of Triple P-Positive Parenting Program and Parent-Child Interaction Therapy (Thomas & Zimmer-Gembeck, 2007). These programs emphasise the role of parents in the development and maintenance of child behaviour problems. Specifically, they focus on responding to the child's prosocial behaviour with a reward, and responding with minimal attention to undesirable behaviour (Thomas & Zimmer-Gembeck, 2007). Current parenting programs may help to inform the basis for how ST behaviour is shaped, as well as identifying targets for intervention.

Similar to behaviour parenting programs, parents may also encourage ST habits through reinforcement principles. Parents' use of handheld devices as disciplinary tools of behaviour has become increasingly common. Research has suggested that parents may allow their child to use devices as a reward for good achievement, and may confiscate them as a form of punishment (Samaha & Hawi, 2017). Consistent with operant conditioning principles, parents may give their child a device to de-escalate emotional distress or tantrums; however, this may reinforce the undesirable behaviour. Indeed, rewarding children with a desired object or withholding the object tends to increase the object's attractiveness and desirability, and thus may unintentionally lead to increased ST (Samaha & Hawi, 2017).

Research has found that surpassing recommended ST limits is positively associated with parents' utilisation of handheld devices as disciplinary tools, in particular as a reward or punishment, or to keep a child occupied (Samaha & Hawi, 2017). Jago et al. (2016) reported similar findings that are also comparable to the dietary literature, which has indicated that encouraging children to eat specific foods (e.g. vegetables) before they are permitted to eat dessert may increase their preference for the rewarded food (Ritchie et al., 2005). These learning theories indicate that ST is a learnt behaviour shaped by parents, who may contribute to its increased use among children.

Coercive Family Processes

Coercive family processes, an extension of operant conditioning principles, may further explain the increase in child ST, and consequent undesirable child behaviour and emotion dysregulation. Patterson (1982) theorised a process of mutual reinforcement in which the parent inadvertently reinforces the child's misbehaviour, resulting in parental negativity (i.e. increased yelling, aggression), leading to further child misbehaviour, and so on, until the interaction is discontinued when either the parent or child surrenders. For example, when a child is requested by a parent to stop engaging with their handheld device, a child may initially ignore the parent. As the parent raises their voice in tone and volume to enforce the request, the child may outright refuse to comply. This may lead to the child yelling at the parent, resulting in the parent yelling at the child, and vice versa, until the parent surrenders. When these behaviours lead to the parent ceasing to repeat the request, the child will reproduce them in the future, as they have learnt that the parent eventually surrenders (Patterson, 1976, 1982). This has implications for the child's socio-emotional development, with the child learning an aggressive pattern of relating to others outside their family as well, including their peers and teachers (Smith et al., 2014). By contrast, if the coercive cycle leads to the child surrendering, the parent learns that they need to deploy

coercive strategies for the child to comply with their request. This may lead to further strain and stress in the parent-child relationship. Importantly, the introduction of threatened or actual withdrawal of screens may function to negatively reinforce desirable behaviour or negatively punish undesirable behaviour.

As these types of interactions recur, the child's behaviour becomes more difficult to manage, and the parent becomes more frustrated (Patterson, 1976, 1982). As the child continues to misbehave, they are unlikely to receive attention and positive feedback from the parent, even when they start to display desirable behaviour. When a child receives minimal positive reinforcement for desirable behaviour in the form of praise or encouragement, this is likely to lead to difficulties in academic and peer settings, which will have negative developmental implications for adolescence (Patterson, 1976, 1982).

Current research has demonstrated the impacts of use of screens as a regulatory tool to manage child misbehaviour and distress. As noted earlier, Hawi and Rupert (2015) showed that when parents use devices as regulatory tools, this increases the likelihood of children surpassing the recommended two-hour daily limit. This is also the case when parents use devices as distraction tools in order to have a break or run errands (Samaha & Hawi, 2017). ST has been described as a highly desirable behaviour, as seen by children, that is difficult to manage within the home, especially when parents give inconsistent messages about the rules and limits set on device use (Jago et al., 2016). Specifically, a randomised controlled trial of Australian children aged between five and twelve concluded that children's ST is negatively associated with mothers' monitoring and discipline and fathers' limit-setting and discipline (Lloyd et al., 2014). Interestingly, reinforcement from parents (e.g. praise) did not show a significant association with child ST, contradicting evidence from prior studies (Lloyd et al., 2014). Regardless, the regulation of screens continues to be a source of conflict and tension in the family home, and it remains a challenge for parents to encourage healthy ST.

Child Screen Time and Developmental Outcomes

With handheld screens becoming increasingly popular and accessible for children, the developmental implications of device use are an area of increasing interest in the literature. During their early years, children's brains are rapidly developing and are vulnerable, and habits ingrained early in life have an impact on later development (Plowman, Stephen, et al., 2010). Healy (2000) posited that ST before the age of seven may displace valuable time from important developmental tasks and healthy behaviours, such as physical activity and imaginative play (Ahn & Fedewa, 2011; Levin & Rosenquest, 2001). These early years of life are critical for brain development, and if unhealthy habits are established early on, they are more difficult to change later. Furthermore, children's early screen usage has been shown to persist in later development (Xu et al., 2016). ST can be a positive, educational and valuable learning tool; however, it can also be negative and restrictive, and produce a variety of developmental problems, such as increased emotional symptoms and conduct problems, reduced prosocial behaviour and interpersonal skills, hyperactivity, and greater peer problems (Genc, 2014; Hinkley et al., 2017; Wu et al., 2017). Nevertheless, Hinkley et al. (2017) found that as screen-based game playing may occur in the context of family and peers, it can facilitate opportunities for interaction and the subsequent development of social and emotion skills. Screens used for the purpose of increasing knowledge and understanding about the world as well as developing essential skills will lend to beneficial outcomes compared to passive and solitary use of screens. It is of particular importance to consider how and where screens are used, in what context, and for what purpose.

Child ST and physical developmental outcomes are a common focus of child-based research. Researchers have posited a dose-response relationship, where elevated levels of ST are associated with less physical activity (Gingold et al., 2013). This may be explained by: a) the less active children are, the more time they have for screen activities, and b) some parents

are more likely than others to provide opportunities for non-screen-related activities (Gingold et al., 2013). Studies have demonstrated that children who spend time outside are likely to be more active, and hence engage in less sedentary behaviour such as ST (Gray et al., 2015; Hinkley & Brown, 2014). At the same time, screen-based activities that involve physically active games have been shown to have similar effects to light to moderate walking, skipping and jogging (Maddison et al., 2007). Additionally, physically active screen games have been shown to improve academic performance, decrease negative classroom behaviours and motivate children to exercise (Lieberman et al., 2011). A meta-analysis of 35 studies by Gao et al. (2015) ascertained that active video gaming is positively associated with positive physiological and psychological responses, such as heart rate and enjoyment. These studies suggest that screen use that encourages physical activity may lead to benefits for children, rather than simply exposing them to ST. Therefore, a better understanding of the developmental implications of handheld ST is needed in order to maximise its benefits and minimise its risks.

There is a growing body of research investigating the effects of ST on academic outcomes for children. In particular, the global COVID-19 pandemic has pushed children towards more online forms of learning, while public health lockdown restrictions have led to increased child ST. Children in Canada, China and Korea (Guan et al., 2020; Xiang et al., 2020) were reported to engage in greater recreational ST during the pandemic, whilst this was discrepant to children in Australia (Nathan et al., 2021). This may be due to methodological differences regarding the onset and duration of restrictions, as well geographically, Australia was experiencing warmer weather during this time where children were more likely to engage in outdoor play. Nevertheless, the evolution of technology, from TV to computers to handheld devices, has presented opportunities for these to be used as educational tools (Tahir & Arif, 2015). Indeed, use of screens for educational purposes in ways that are age-

appropriate can be beneficial for children's academic development (Anderson et al., 2001; Furió et al., 2015; Hennessy et al., 2015; Kim & Frick, 2011; Kirkorian et al., 2008). However, the current research base contains conflicting evidence, particularly pertaining to children beginning school. Children who spend more time on screens are more likely to spend less time on tasks such as homework or reading, which are crucial for enhancing academic performance (Shin, 2004; Syväoja et al., 2013). This is consistent with time displacement theory, where ST displaces time that might otherwise be spent on other, academically enriching activities. In addition, children are highly attracted to the visually and auditory stimulating properties of ST, such as interactive characters and colourful images, whereas academic activities require more active and intellectual stimulation (Dumuid et al., 2017; Shin, 2004). Thus, this research demonstrates that ST can be beneficial if content and duration of usage are moderated.

Researchers have voiced concerns about the potential of ST to influence the emotional and social development in children. From an attachment theory perspective, children have an innate drive to connect with others, and reciprocal interactions between a parent and child during daily activities are necessary in order for a parent to be attuned to their child's emotions, and for a child to learn self-awareness of such emotions (Zero to Three, 2010). If these interactions are disrupted by the parent handing a device to the child, this may lead to developmental difficulties. A study found that when parents use a mobile phone to distract a crying child during diapering, this can affect social-emotional skills learning (Raman et al., 2017). A child's cry is an opportunity to build trust, whereby a parent may provide reassurance through their body language, facial expressions, gentle touches or a soothing voice (Erikson, 1993). Therefore, the introduction of a screen may disrupt the underlying social-emotional skill-building processes which occur organically between a caregiver and a child (Raman et al., 2017). Moreover, as ST tends to be a relatively solitary and sedentary

activity, it reduces opportunities for children to engage with their peers and thus develop healthy social skills (Lewinsohn, 1974; Varni et al., 2014). Social skills are needed to facilitate school readiness (Denham, 2006) and peer acceptance (Lindsey, 2002). However, opposing evidence suggests that handheld devices offer increased social connection to distant family and friends, and that their interactive nature may benefit cognitive and social skills learning as compared to passive forms of ST (Troseth et al., 2016). Although there is evidence to suggest developmental concerns related to increased ST, these studies are of a cross-sectional nature, and thus it is difficult to infer causality and determine how the trajectory of a child is affected across time.

Excessive ST has the potential to disrupt attachment processes. Parents who engage in excessive ST may be limiting opportunities and time for meaningful, relationally-based interactions with their child and, consequently, affecting the child's optimal developmental trajectory (Kildare & Middlemiss, 2017). For example, if a parent is distracted by a screen, they will be unable to appropriately respond and attend to a child's emotional stimuli. This may result in lower quality parent-child interactions (Oduor et al., 2016; Radesky et al., 2014). It is also known that parental ST is likely to lead to increased child ST (Lauricella et al., 2015), presenting a further avenue for attachment disruption. Similarly, children engaging with devices may be less responsive and sensitive to their parents (Oduor et al., 2016; Radesky et al., 2014). For children who do not form healthy attachment bonds with the caregiver during sensitive developmental periods, this may lead to further difficulties in adulthood.

Studies with adolescents have found associations between attachment and ST, which may inform findings about younger children. Richards et al. (2010) investigated the association between traditional forms of ST and attachment to parents in adolescents. This study found that increased TV and computer use among adolescents was associated with poor

attachment to parents, while higher levels of computer and console use was linked to poor attachment to peers. One possible explanation is that these adolescents may struggle with more immediate family and peer relationships, preferring online friendships or spending more time in their bedrooms on their screens rather than interacting with others (Richards et al., 2010). However, this study was limited in that it did not differentiate between activities engaged in on screens. Richards et al. (2010) also established that children engaging in homework or reading show greater attachment to their parents. With screens increasingly used for learning purposes, and with the popularity of digital books, ST per se may not necessarily lead to poor relational outcomes. Another study reported similar findings to Richards et al. (2010), whereby male adolescents who viewed TV programs with violent content were more likely to have poorer family functioning (Chowhan & Stewart, 2007). This study highlighted the importance of a rating system for ST content rather than just guidelines on the age-appropriateness of ST exposure. This may be an area for policymakers to consider when modifying guidelines for ST. Although these studies focused on adolescents, since attachment processes occur at an early age and ST tends to persist in later life, it may be expected that young children experience similar outcomes.

While concerns have been raised about the negative effects of elevated ST, relatively little is known about the positive effects of ST. Research to date suggests that ST can increase a child's knowledge and understanding of the world, enhance their operational skills, be a medium for communication with distant family and friends, increase play opportunities, and facilitate exploration in content areas such as reading (Downing et al., 2015; McPake et al., 2013; Radesky, Schumacher, et al., 2015). For children with autism spectrum disorder (ASD), ST has been shown to improve language and communication skills through video modelling, more effectively so than live human presentations (Shane & Albert, 2008). Various applications on handheld devices have been created to improve the emotional and

social skills of children with ASD. As these children tend to be visual learners, handheld devices appeal to them, and enable them to engage more adaptively through learning based on pictures, video or sound (Gay & Leijdekkers, 2014). In moderation, it appears that ST can be a valuable learning tool and facilitate healthy development in children, particularly those with ASD.

ST has provided an avenue to facilitate and support learning for not only children with developmental difficulties, but also in the general population (Papadakis & Kalogiannakis, 2017). These applications of ST have shown positive effects if they are developmentally appropriate for the child's age (Papadakis & Kalogiannakis, 2017). Handheld devices are becoming more widely used across educational institutions, as children are more easily able to manipulate a tablet or iPad than a computer, given their portability and navigator-friendly buttons (Papadakis & Kalogiannakis, 2017). However, it is important to distinguish between children who are using screens as an extension to traditional learning and those who are using screens passively. These educational applications of ST have the potential to change the learning landscape for children, as they provide another avenue of learning (Papadakis & Kalogiannakis, 2017). Interestingly, a longitudinal study by Sanders et al. (2019) demonstrated that educational ST is associated with improved educational outcomes, and shows no negative consequences for other outcomes. It also found that interactive ST can be both harmful and beneficial, indicating the complexity of the effects of ST. However, this study may not be applicable to contemporary ST, as the data were collected during 2010-14. Although there is evidence to suggest some positive impacts of ST, it is an area that requires further investigation.

Given the significant role that parents play in a child's life, their own mental health may affect their capacity to provide an optimal and nurturing environment for healthy development. Indeed, research has shown that children with depressed or anxious parents are

more likely to develop developmental difficulties, such as, poor social skills, low emotional competence, increased conduct and depressive symptoms, attachment difficulties, poor school performance and sleep issues (Chronis et al., 2007; Eckshtain et al., 2018; Edwards et al., 2010; Luoma et al., 2001; Shen et al., 2016; Toth et al., 2009). It is likely due to the fact that parents with mental health difficulties modelling certain behaviours in response to distress, being less available for or skilled at parenting, having difficulties with supporting children's social activities, and providing regular daily routines, or being less responsive and sensitive to their child's needs (Dodge, 1990; Frankel & Harmon, 1996; Lyons-Ruth et al., 2002). The impact of parental mental health on child development is well-known and widely researched; however, it is unclear how these effects may differ within the context of use of handheld devices.

There is a gap in the literature regarding parental mental health and ST, and existing evidence is conflicting. For instance, Ali et al. (2020) demonstrated that maternal mental health is not significantly associated with excessive smartphone use. However, the majority of participants within this study did not engage in smartphone use that was considered "addictive", and they were drawn from a community sample that was less likely to exhibit mental health difficulties. Meanwhile, other studies have reported an association between smartphone use and a range of mental health and psychosocial issues, depression and anxiety (Demírcí et al., 2015), social anxiety (Enez Darcin et al., 2016), and loneliness and shyness (Bian & Leung, 2015). These studies, though, sampled from university students and thus it is unclear whether the findings are representative of people who have parenting responsibilities and may be experiencing other stressors such as financial, work or household burdens.

Given the ambiguous nature of current findings, one potential prediction is that parents with mental health difficulties may be more likely to engage with handheld devices. As discussed previously, since this population of parents may have limited capacity for

sensitively and appropriately responding to their child, it is hypothesised that they may use ST as a way to disengage and distract themselves from the demands of parenting and other responsibilities. Moreover, anxious parents may use their device as a form of avoidance in social interactions. As parental ST is closely associated with child ST, it is predicted that parents' use of handheld devices may further impact the parent-child dynamic and, consequently, the developmental trajectory in children. Indeed, a study on children aged between five and eight observed that maternal stress was associated with greater child ST (McArthur et al., 2021). An interesting finding from this study was that families that were struggling with high psychological or financial stress during the COVID-19 pandemic, were likely to have children engaging with greater recreational screen use compared to those that had lower levels of stress (McArthur et al., 2021). These are speculating hypotheses in regards to the reciprocal relationship between parental mental health and ST, and further outlines there is much more to be explored regarding this area.

As discussed, there are both positive and negative effects of children's ST, and it appears that elevated levels of ST are related to negative implications for development. The current literature examining ST and developmental outcomes in children has mainly focused on traditional forms of ST rather than handheld devices. Within this literature, the majority of studies have investigated physical developmental outcomes. Moreover, the current research is focused on Western cultures, and considering the mass use of handheld devices worldwide, there is a lack of understanding of the effects of these devices in non-Western cultures. There is also limited evidence on the emotional, behavioural and social developmental outcomes of handheld device use by young children, and therefore further research is needed to provide a greater understanding and awareness of such implications.

The Present Research

The increase in handheld device use has given rise to a variety of questions on the effects and implications of children's use of these devices. It is apparent that children are currently exceeding the recommended daily limit, even as these devices continue to increase in popularity and accessibility. Our knowledge and understanding of how parents, especially parents with mental health challenges, facilitate the use of handheld screens by young children is limited. A number of theoretical frameworks have highlighted the importance of the system surrounding the child, particularly the influence of parents, for a child's development and wellbeing. In order to inform safe practices and interventions to manage healthy screen habits, it is important to understand the parental factors underpinning such habits, and their impact on later childhood development. While there is a vast focus in the research on the developmental concerns relating to such devices, there appears to be limited investigation using prospective designs to track the trajectory of children. Moreover, there is a gap in our knowledge of the relationship between parental mental health and child ST. Since parents are key drivers of their child's wellbeing, it is envisaged that increased understanding of parents' own wellbeing can have early positive intervention effects. With the current literature weighted towards the detrimental childhood outcomes of handheld screen use, it is important to investigate the question of what can be achieved to maximise the benefits of ST so that children flourish and develop appropriately. The proposed study will aim to address these gaps in the literature by:

1. Examining the relationship between ST and parental mental health during early childhood. Specifically, what range of parental characteristics impact a child's screen time?

2. Investigating the effects of ST on children's developmental outcomes. In particular, what effects does ST have on the social, emotional, and behavioural development in children?

This research seeks to obtain data which will help to address these research gaps and extend the current ST literature with the goal of improving children's wellbeing and development. It has the potential to assist parents, teachers, health professionals and the wider community to build a healthier screen environment for children, particularly in light of the popularity of handheld devices among today's generation. It is also envisaged that this research will provide additional evidence for establishing or modifying current guidelines and policies for the safe and appropriate use of handheld devices.

Prelude to Chapter Two

The upcoming chapter is a longitudinally designed study of children aged four to five years which focuses on the effects of traditional forms of ST on academic outcomes in children. This chapter provides detail on the ST literature from the last 12 years within this context in a broader and normative representative sample of Australian children. In particular, this study sought to examine the effects of TV viewing, and computer and gaming console use, on academic achievement, as measured by the National Assessment Program for Literacy and Numeracy (NAPLAN) in five domains. These domains were: reading, writing, numeracy, spelling and grammar/punctuation.

CHAPTER 2: The Effects of TV Viewing, Computer and Gaming Console Use on Academic Achievement: A Longitudinal Study

The Effects of TV Viewing, Computer and Gaming Console Use on Academic Achievement: A Longitudinal Study

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Abstract

Early learning experiences are crucial for children's optimal development. The rising prevalence of screen time (ST), such as TV viewing, computer and console use, in children's lives have raised concerns regarding their effect on academic outcomes (Gingold et al., 2013). This study used a longitudinal design to examine the effects of the amount of ST on academic achievement. Data was obtained from the *"Growing Up in Australia: The Longitudinal Study of Australian Children (LSAC)"* (Soloff et al., 2005) and focused on children from this cohort who were 4-5 years of age on enrolment (*N*=2954). The National Assessment Program for Literacy and Numeracy (NAPLAN) was used to measure five academic domains: reading, writing, numeracy, spelling and grammar/punctuation at two time points. The results showed that higher levels of ST at Time 1 (T1) demonstrated a negative association with Year 3 NAPLAN scores in reading (B= -5.94), writing (B= -3.08), numeracy (B= -4.85), spelling (B= -4.03), and grammar/punctuation (B= -5.74). Increased ST at Time 2 (T2) demonstrated a significant negative association with only Year 5 NAPLAN scores in grammar/punctuation (B= -2.72). ST at T1 predicted lower scores on the Year 5 NAPLAN in reading (B= -1.67), writing (B= -2.36), and grammar/punctuation (B= -1.96). This effect was not observed for numeracy and spelling. Overall, these findings illustrate that more ST leads to a decreased performance in academic achievement over time, although this was not present across all domains. These findings may have implications for educational settings, especially given that the NAPLAN provides fundamental feedback regarding children's academic performance.

Keywords: screen time; media exposure; academic achievement; learning; academic performance

Introduction

During the early developmental years, the immature brain is vulnerable as it rapidly develops, and behavioural habits ingrained early in life have an impact on later development (Knudsen, 2004). The effects of behaviours such as prolonged screen time (ST) has been widely researched and is recognised as a predictor of academic achievement (Poulain, Peschel, et al., 2018). ST refers to time spent viewing electronic media, such as television (TV), computers, video game consoles, smartphones, iPads or tablets (Yilmaz et al., 2015). The American Academy of Pediatrics (2016b, 2016c) have recommended children aged 2-5 years old spend an average of one hour per day on screens, and for older children to spend up to two hours per day, and this is similar to guidelines published by the Australian Government (Department of Health, 2014). Therefore, children engaging in more than two hours of ST per day is considered excessive in accordance to health guidelines for this age group. Poulain, Peschel, et al. (2018) suggested that differences in children's education and career opportunities become prominent in a child's early development. Studies have shown that greater ST, particularly during critical developmental periods, may have subsequent effects on social interactions with family and peers, regulation of emotion, behaviour, academic achievement and adaptive functioning (Thomas & Knowland, 2009). However, the current evidence is ambiguous regarding the effect of early ST use on later academic achievement in children particularly during primary school.

The effects of ST is particularly important for young children, as there is rapid development and learning during the early years of life (Knudsen, 2004). Researchers have posited that children become active viewers of TV by preschool age compared to when they are infants and toddlers (Kirkorian et al., 2008). Preschool children pay less attention to perceptually salient features, and are able to attend to informative features including dialogue and narrative (Huston & Wright, 1983). Engaging with TV inhibits attentional processes and

increases impulsive behaviour, due to the fact that TV utilises frequent movements and rapid images (Anderson et al., 2001). It is possible that this behaviour, when translated to the classroom, could present as difficulties with concentration and staying on task.

Primary school-aged children are attracted to ST due to its visually stimulating and auditory effects in comparison to their school-related tasks that require active intellectual stimulation (Dumuid et al., 2017; Shin, 2004). ST, such as watching movies/TV shows or engaging in games, may require less mental effort compared to learning activities, such as reading. One hypothesis is that as a child's attention to screens increases, the less likely they are to put the mental effort into acquiring academic skills (Shin, 2004). Children will choose to engage in ST, as it is visually entertaining and easy to understand. Overall, it appears that children have a preference towards any amount of ST as it requires less mental effort and consequently affects important attention processes and influences children's ability to engage with academic learning.

Time displacement theory proposes that time spent on screens may reduce time spent on intellectually demanding activities, such as homework, studying, or reading for leisure (Shin, 2004; Syväoja et al., 2013) and lead to poor academic achievement. Sufficient sleep is known to facilitate a healthy lifestyle and optimise academic achievement, and time on screens may affect time spent sleeping (Faught et al., 2017; Syväoja et al., 2013). ST prior to sleep is linked to increased arousal and disrupted melatonin production, and affects attention and concentration levels, which are critical for engagement with learning (Kubota et al., 2002).

There is limited work examining the impact of the relationship between ST on academic achievement within the under six age group and the majority of studies examine adolescent cohorts despite the early childhood to primary school period being a more sensitive time for learning and development (Thomas & Knowland, 2009). In current

prospective studies that focused on adolescent cohorts (Johnson et al., 2007; Nelson et al., 2006; Poulain, Peschel, et al., 2018), greater TV viewing was associated with poor homework completion, lower grades, negative attitudes towards school and long-term academic failure (Johnson et al., 2007). Nelson et al. (2004) and Poulain, Peschel, et al. (2018) confirmed these findings, and further considered other lifestyle behaviours, such as sleep and physical activity.

Interestingly, one longitudinal study followed children from five years to 19 years of age and found that increased TV viewing of educational content at age five was associated with higher grades in adolescence for boys. This trend was also identified in girls, however it was not a statistically significant finding (Anderson et al., 2001). In contrast, girls who were exposed to violent content on TV at age five were associated with lower grades in adolescence, where no significant findings were observed for boys. It appears that ST that is informative, age-appropriate, and educational may facilitate learning and academic success, compared to ST that is purely for entertainment purposes or contains violent content (Anderson et al., 2001; Kirkorian et al., 2008). However, discrepant findings were observed and further highlighting the inconsistency of results.

Most of the previous longitudinal studies have measured academic achievement through grades rather than a standardised assessment tool (Anderson et al., 2001; Johnson et al., 2007; Nelson et al., 2006; Poulain, Peschel, et al., 2018). In addition, Faught et al. (2017) conducted a prospective study of primary school-aged children and showed that children who met ST health recommendations were more likely to perform at an expected age level for writing exams. Grasby and Coventry (2016) highlighted the societal importance of the acquisition of both literacy and numeracy skills. As academic achievement encompasses a variety of domains, such as numeracy, writing, reading, spelling and language, it is unclear what the effects of ST is on such domains.

The evidence investigating the relationship between ST and academic achievement is conflicting and often derived from analytic cross-sectional studies. For instance, researchers have reported that increased engagement with ST disrupts academic activities, and has negative consequences for academic achievement (Aguilar et al., 2015; Howie et al., 2020; Sharif & Sargent, 2006). In a systematic review of 232 studies, the authors identified 35 studies that focused on the relation between sedentary behaviour, referred to as range of behaviours with low energy expenditure performance (e.g. sitting, watching TV, playing video games), and academic performance (Tremblay et al., 2011). Specifically, ST that is of a passive nature is typically considered as sedentary, where gaming that consisted of active movement was excluded. Within this subset, 32 of the 35 studies were cross-sectional and the remaining three studies were longitudinal, and only one study examined children under six years of age. The majority of cross-sectional studies reported that school-aged children exposed to more than two hours of ST daily, were more likely to perform poorly academically, however 10 of these studies did not report a significant relationship. Moreover, the longitudinal studies found that children watching more than an hour of TV daily was associated with attention difficulties in their adolescence. In this review, the definition of academic achievement varied across studies and was not well harmonised. These findings highlight the discrepancy between studies and the need for longitudinally designed studies with consistent definitions of academic achievement to permit comparison of these effects between studies and over time.

Further support for the ambiguity in the field concludes that ST has also shown positive associations with academic achievement (Jackson et al., 2011; Syväoja et al., 2013) or had no association at all (Munasib & Bhattacharya, 2010). Among these studies, there were differences regarding the collection of data on ST including Jackson et al. (2011) who specifically measured internet use and videogame playing, whereas Syväoja et al. (2013) had

children self-report on their ST and Munasib and Bhattacharya (2010) only collected data on TV. Interestingly, Jackson et al. (2011) findings were only present among children who had below average reading skills. Given these findings, further research would be useful to investigate the long-term effects of ST on academic achievement. Another methodological concern in the literature is that the grouping of ages of children vary between studies. Therefore, in this current study, children aged 4-5 years of age were referred to as primary school-aged, as this is the average age of entry for formal schooling in Australia

Study Aims

This study used a longitudinal design in children aged 4-5 years of age to examine the effects of the amount of ST, particular to TV viewing, computer and gaming console use, on academic achievement as measured by the National Assessment Program for Literacy and Numeracy (NAPLAN) on five domains. These domains included: reading, writing, numeracy, spelling and grammar/punctuation.

It is hypothesised that:

1. Higher levels of ST will significantly predict a medium-term negative effect on academic achievement, such that ST at T1 will demonstrate lower scores on the Year 3 NAPLAN and ST at T2 will demonstrate lower scores on Year 5 NAPLAN.
2. Greater ST will significantly predict a long-term negative effect on academic achievement, such that ST at T1 will demonstrate lower scores on the Year 5 NAPLAN.

Method

Primary data was obtained from two large publicly available retrospective datasets. These two datasets included: *"Growing Up in Australia: A Longitudinal Study in Australia (LSAC)"* conducted by the Australian Government Department of Social Services, Australian

Institute of Family Studies and the Australian Bureau of Statistics (Soloff et al., 2005) and the National Assessment Program for Literacy and Numeracy (NAPLAN). The study investigated the experiences of a nationally representative sample of Australian children and their families at specific points across their lifespan. The LSAC began in 2004 with two cohorts: B-cohort (i.e. birth cohort, children born between March 2003 and February 2004) and K-cohort (i.e. kindergarten cohort, children between 4-5 years old in 2004; Soloff et al., 2005). Participants were recruited from the Medicare enrolment database and selected was based on a two-stage cluster sampling (Soloff et al., 2005). Data was obtained from self-report questionnaires, and face-to-face or telephone interviews with the child, their parents or carers, and their teachers (Soloff et al., 2005). The NAPLAN is a standardised national curriculum assessment undertaken by Australian students in Grade 3, 5, 7 and 9 (Australian Curriculum Assessment and Reporting Authority, 2013).

Transparency and Openness

Details regarding sample size, data exclusions and all measures of the study are detailed below. The data obtained for this study is available from the Australian Institute of Family Studies but restrictions apply to the availability of this data, and are not publicly available. Approval was gained to access this data. Data is available from the authors upon reasonable request and with permission of the Australian Institute of Family Studies. Data was analysed using the AMOS version 26.0 software and SPSS, version 27. This study's design and its analysis were not pre-registered.

Participants

Data from Waves 3 and 5 of the B-cohort were investigated (referred to as Time 1 and Time 2; T1 and T2). T1 refers to data collected in 2008-09 where children were 4-5 years old, whereas T2 was collected in 2011-12 where the same children were 8-9 years old. The LSAC data from Waves 3 and 5 was merged with academic achievement data from the NAPLAN.

Data from the Year 3 NAPLAN test was collected in 2011-13 and Year 5 results were collected in 2013-15.

Initially, 3,714 children and their families were recruited. Participants who completed all or partially completed the NAPLAN tests were retained for the final sample, where 750 participants were removed due to incomplete data on the NAPLAN. The final sample consisted of 2,954 children and their families (Child: M_{age} *= 4.25, SD = 0.44;* Parent: M_{age} *= 35.76, SD = 5.08*). The gender distribution was approximately equal for children (*M=50.6%, F=49.4%*), whereas the majority of parents completing the survey were female (97.8%). The majority of parents were born in Australia or New Zealand (82.7%), employed part-time (43.1%), and reported an individual income of less than $25,999 per annum (53.1%) and the highest level of education achieved was Certification (26.6%). Ethics approval was obtained from an Australian Ethics Committee (Gray & Sanson, 2005). See Table 1 for demographic characteristics of the sample at T1.

Table 1: Demographic characteristics of the sample at T1 collected in 2008-09 (N=2954)

Characteristics	**%(N)**
Child Gender	
Male	50.6(1494)
Female	49.4(1460)
Parent Gender	
Male	2.2(65)
Female	97.8(2889)
Parent's Country of Birth	
Australia & New Zealand	82.7(2442)
Pacific Islands	.6(19)
North-West Europe	5(147)
South and East Europe	.5(15)
Africa	.9(28)
Middle East	1.1(32)
East Asia	2.7(81)
South and Central Asia	1.6(47)
The Americas	1.1(32)
Missing	3.8(111)
Highest Education Level of Parent	
Certificate	26.6(787)
Advanced diploma/diploma	10.2(301)
Bachelor degree	22.2(657)
Graduate diploma/certificate	7.9(232)
Postgraduate degree	8.1(239)
Other	1.9(56)

Characteristics	%(N)
Missing	23.1(682)
Parental Individual Income (AUD)	
<$25,999	53.1(1569)
$26,000-$51,999	29.2(863)
$52,000-$103,999	12.5(369)
>$104,000	2.3(69)
Missing	2.8(84)
Work Status	
Full-time	22.3(659)
Part-time	43.1(1274)
Employed and on maternity leave	2(60)
Unemployed and looking for work	1.8(54)
Unemployed	30.7(907)

Measures

Demographic Variables

Parents' demographics included age, gender, country of birth, highest education level, individual parental income and work status. Child gender was also reported.

Screen Time

In the LSAC data, parents reported how much time in hours and minutes their child spent on ST, specific to TV, computers and gaming consoles on a typical weekday and weekend day. This item was reported as a continuous measure. To calculate average daily ST, weekday times were multiplied by five and weekend day times were multiplied by two, and then summed together and divided by seven.

Academic Achievement

The NAPLAN was used to measure academic achievement. There are five assessment domains which included reading, writing, numeracy, spelling, and grammar/punctuation. Scores ranged from 0 to 1, 000 (i.e. scaled scores) and correspond to 10 performance bands. Band 1 corresponds to the lowest level of achievement, whilst Band 10 indicates the highest level of achievement (Australian Curriculum Assessment and Reporting Authority, 2013). Based on previous studies using NAPLAN data (Burrows et al., 2017; O'Dea & Mugridge, 2012), the current study utilised NAPLAN scale scores over performance bands as a measure

of academic achievement and to increase statistical sensitivity for analyses. This is because each performance band consists of a range of scale scores and is not specific to a cut-off point.

Analysis Plan

Initially, bivariate correlational analyses were conducted to assess for associations between study variables. The AMOS version 26.0 software was used to conduct structural equation modelling. Estimation likelihood maximisation was used to estimate the missing data. Based on the final sample of 2,954 parent-child dyads, 65 dyads were missing on the T2 ST measures. Moreover, 0.8-1.2% of cases were missing Year 3 NAPLAN scores (Reading=30, Writing=32, Numeracy=35, Spelling=25, Grammar/Punctuation=25) and 0.6-1.1% were missing Year 5 NAPLAN scores (Reading=19, Writing=32, Numeracy=30, Spelling=20, Grammar/Punctuation=20).

Five models were conducted. Each model tested the effects of early ST use at two time points on Year 3 and Year 5 NAPLAN on five domains: 1) reading, 2) writing, 3) numeracy, 4) spelling and 5) grammar/punctuation. Medium-term effects were defined as an association between ST at T1 (2008-09) to Year 3 (2011-13) and ST at T2 (2011-12) to Year 5 (2013-15), a change across approximately 3-5 years. In contrast, a long-term effect was referred to as ST at T1 (2008-09) to Year 5 (2013-15), a change across 5-7 years. Each model was performed as adjusted and unadjusted with covariates, which include parental employment status and individual income, and to identify the model with best fit. Model-fit was assessed using the chi-square statistic (χ^2), Root Mean Square Error of Approximation (RMSEA; Browne & Cudeck, 1992), the Tucker-Lewis Index (TLI; Tucker & Lewis, 1973) and the Comparative Fit Index (CFI) (CFI; Bentler, 2011). In this analysis, a model was deemed acceptable if the chi-square was non-significant with probability values larger than 0.05. Acceptable parameters for RMSEA were either <0.05 (Byrne, 2016) or < 0.08 (Kline,

2016). For TLI and CFI, values > 0.9 were good (Bentler & Bonett, 1980) and >0.95 was deemed better (Hu & Bentler, 1999; Kline, 2016).

Results

See Table 2 for means, standard deviations and bivariate correlations between variables. Specific to covariates, ST at T1 was negatively associated with parental employment status and individual income. That is, ST was more likely to increase for children with parents who were unemployed or had an individual income of less than $52,000 per annum.

Table 3 demonstrates model-fit indices for all tested models. All models that did not control for covariates showed acceptable levels of model-fit across all indices, except for Model 1, Model 4 and Model 5 that included reading, spelling and grammar/punctuation as an outcome variable, respectively. These three models did not produce a chi-square statistic within the acceptable range. However, the CFI values for the two models that included reading, numeracy, and spelling as outcome variables and controlled for covariates fell within the acceptable range. Researchers have recognised concerns with the chi-square statistic, as it encourages the use of small samples in order to retain the null hypothesis (Bentler & Bonett, 1980). This may lead to inaccurate fit of the data and less precise estimates of the parameters in a model (West et al., 2012). Because of these issues, other commonly used indices of fit are utilised, such as the RMSEA, TLI and CFI (West et al., 2012). As the current study employed a large sample size and the models that did not control for covariates had acceptable levels of fit of the data across these indices, these models were retained for analyses.

Table 2: Means, Standard Deviations and Bivariate Correlations among Key Study Variables and Covariates (N=2954)

Variable	M(SD)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. T1ST	2.47(1.57)	1													
2. T2ST	2.74(1.58)	-.03	1												
3. Y3 Reading	439.91(89.76)	-.11**	.04*	1											
4. Y3 Writing	425.66(60.73)	-.11	.02	.56**	1										
5. Y3 Numeracy	412.13(73.52)	-.11**	.02	.69**	.52**	1									
6. Y3 Spelling	421.14(77.66)	-.09**	-.05*	.66**	.61**	.61**	1								
7. Y3 Grammar/ Punctuation	441.99(92.90)	-.10**	.08**	.74**	.60**	.66**	.72**	1							
8. Y5 Reading	520.31(77.55)	-.10**	.03	.77**	.49**	.64**	.59**	.68**	1						
9. Y5 Writing	480.64(63.86)	-.10**	.04	.50**	.54**	.47**	.54**	.54**	.528**	1					
10. Y5 Numeracy	503.62(70.65)	-.09**	.02	.61**	.46**	.76**	.54**	.60**	.656**	.475**	1				
11. Y5 Spelling	504.45(71.87)	-.07**	.03	.63**	.57**	.57**	.85**	.69**	.62**	.58**.	.56**	1			
12. Y5 Grammar/ Punctuation	520.80(82.96)	-.12**	-.12**	.02	.69**	.53**	.64**	.66**	.70**	.73**	.54**	.67**	1		
13. Employment Status		.10**	.01	-.08**	-.08**	-.07**	-.06**	-.06**	-.06**	-.08**	-.07**	.06**	-.09**	1	
14. Annual Income		-.08**	.00	.09**	.10**	.09**	.08**	.08**	.09**	07.**	.010**	.09**	.09**	-.28**	1

*p < 0.05 ** p < 0.001

Note. T1ST refers to screen time at first time point, and T2ST refers to screen time at second time point.

Table 3: Model-Fit Indices

Tested Models	df	χ^2	p-level	RMSEA	TLI	CFI
1. Reading	1	6.88	.01	.05	.98	1.00
2. Writing	1	.47	.49	<.001	1.00	1.00
3. Numeracy	1	1.70	.19	.02	1.00	1.00
4. Spelling	1	7.47	.01	.05	.98	1.00
5. Grammar /Punctuation	1	15.75	<.001	.07	.93	.99
6. Reading (AWC)	8	266.90	<.001	.11	.77	.91
7. Writing (AWC)	8	261.97	<.001	.10	.49	.81
8. Numeracy (AWC)	8	262.72	<.001	.10	.76	.91
9. Spelling (AWC)	8	262.42	<.001	.10	.83	.94
10. Grammar/ Punctuation (AWC)	8	278.55	<.001	.11	.70	.88

Note. AWC = adjusted with covariates.

Figure 1-5 displays the direct effects models for the Models 1 to 5 that demonstrated acceptable levels of model-fit. In Model 1 to 5, ST at T1 had a negative association with Year 3 NAPLAN scores in all five domains including reading (B= -5.94, SE= 1.05), writing (B= -3.08, SE= 0.71), numeracy (B= -4.85, SE= 0.86), spelling (B= -4.03, SE= 0.91), and grammar/punctuation (B= -5.74, SE= 1.09). That is, for every increase in an hour of ST predicted a decrease of approximately three scaled score units in reading. Overall, higher levels of ST at the age of 4 to 5 years old significantly predicted lower scores on academic achievement in Year 3. In Model 5, ST at T2 contributed significantly towards Year 5 NAPLAN scores in grammar/punctuation (B= -2.72, SE= 0.7) and did not show significant associations for the remaining four domains. In addition, across all models, ST at T1 demonstrated a significant negative path to ST at T2 (B= -0.04, SE= 0.02). This indicated that greater ST at an early age slightly predicted decreased ST at a later age. Interestingly, in Model 1, 2 and 5, ST at T1 demonstrated a negative association with Year 5 NAPLAN scores on reading (B= -1.67, SE= 0.58), writing (B= -2.36, SE= 0.64), and grammar/punctuation

(B= -1.96, SE= 0.7), respectively. Furthermore, across all models, Year 3 NAPLAN significantly predicted Year 5 NAPLAN scores on all five domains, where higher scores in Year 3 demonstrated greater scores in Year 5.

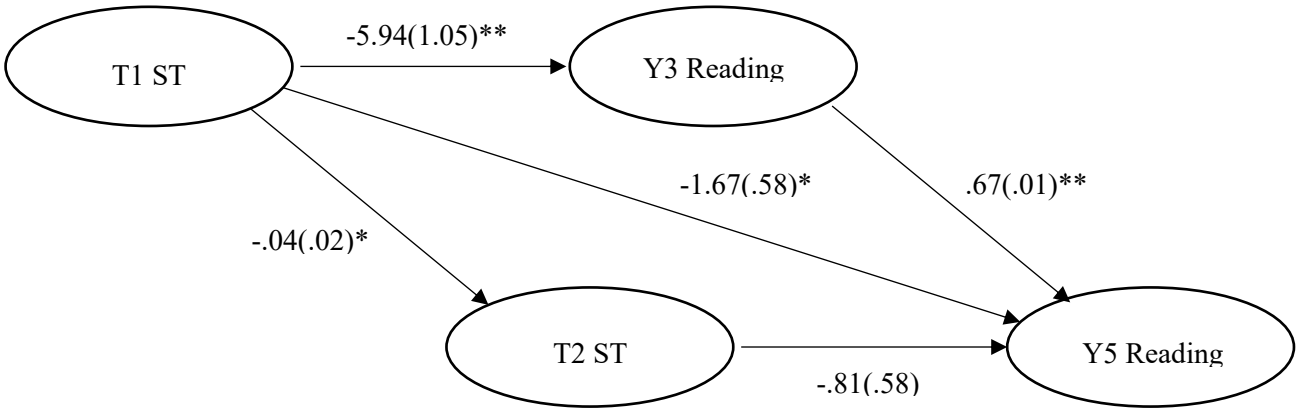

Figure 1. Model 1: Direct effects of screen time and NAPLAN reading scores. Numbers represent unstandardized coefficients (standard error). T1 ST = screen time collected at first time point; T2 ST = screen time collected at second time point; Y3 = Year 3; Y5 = Year 5.
Note: Error terms have been omitted for clarity of presentation.
*p < .01; **p < .001.

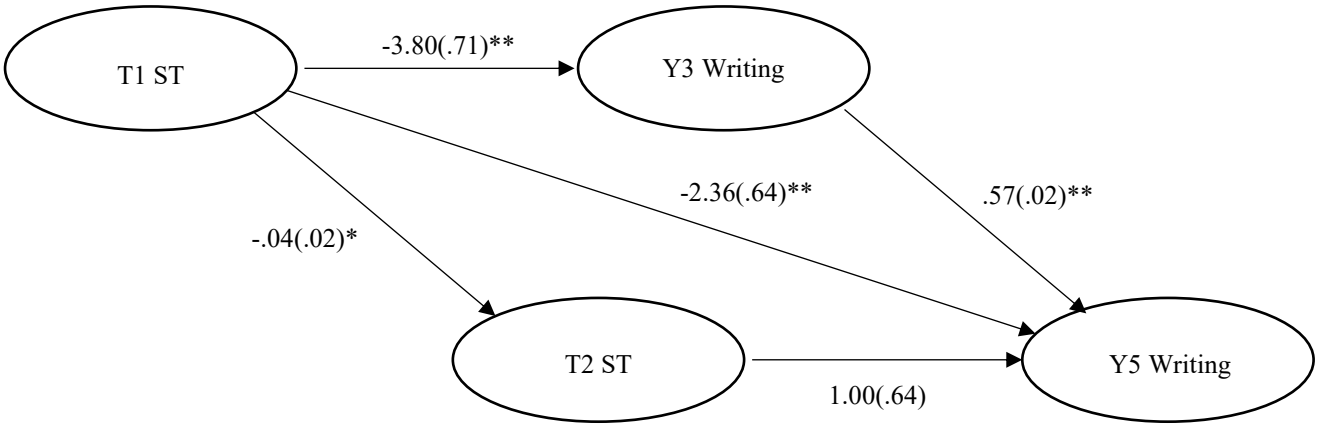

Figure 2. Model 2: Direct effects of screen time and NAPLAN writing scores. Numbers represent unstandardized coefficients (standard error).T1 ST = screen time collected at first time point; T2 ST = screen time collected at second time point; Y3 = Year 3; Y5 = Year 5.
Note: Error terms have been omitted for clarity of presentation.
*p < .01; **p < .001.

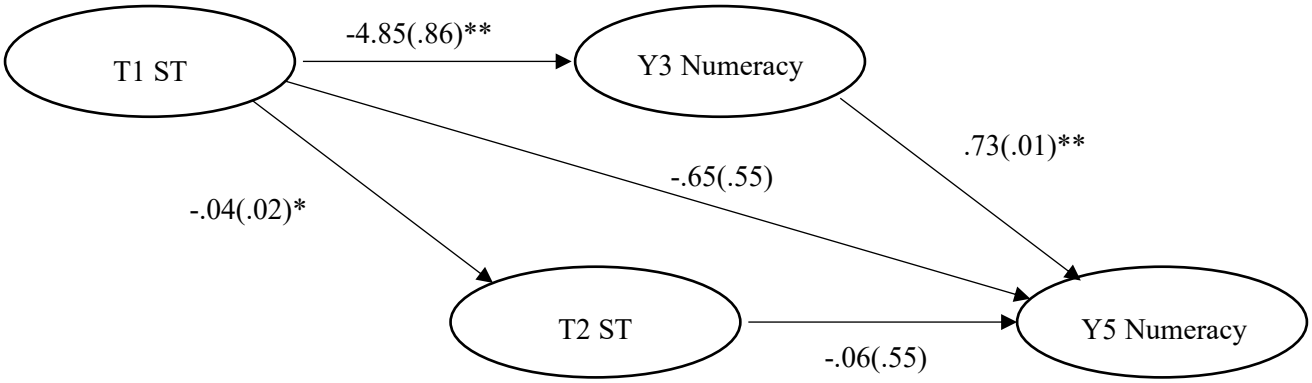

Figure 3. Model 3: Direct effects of screen time and NAPLAN numeracy scores. Numbers represent unstandardized coefficients (standard error); T1 ST = screen time collected at first time point; T2 ST = screen time collected at second time point; Y3 = Year 3; Y5 = Year 5.
Note: Error terms have been omitted for clarity of presentation.
*p < .01; **p < .001.

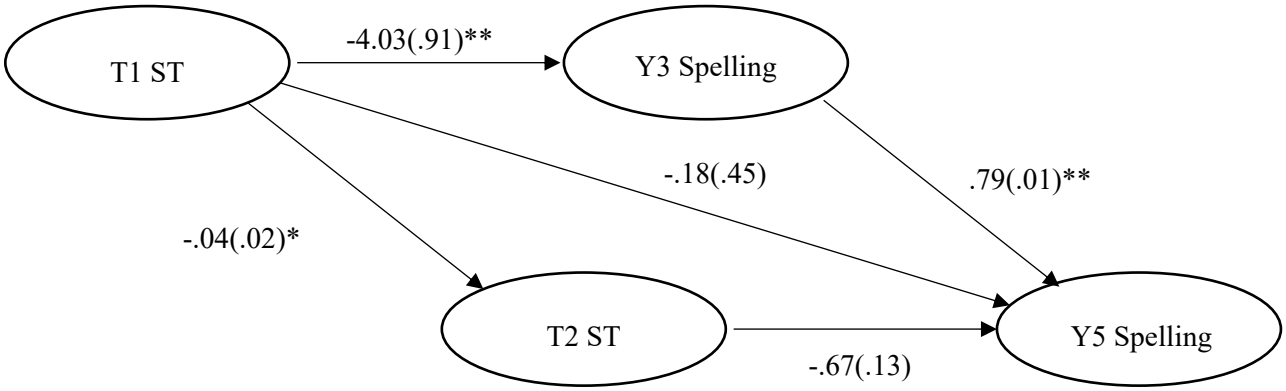

Figure 4. Model 4: Direct effects of screen time and NAPLAN spelling scores. Numbers represent unstandardized coefficients (standard error); T1 ST = screen time collected at first time point; T2 ST = screen time collected at second time point; Y3 = Year 3; Y5 = Year 5.
Note: Error terms have been omitted for clarity of presentation.
*p < .01; **p < .001.

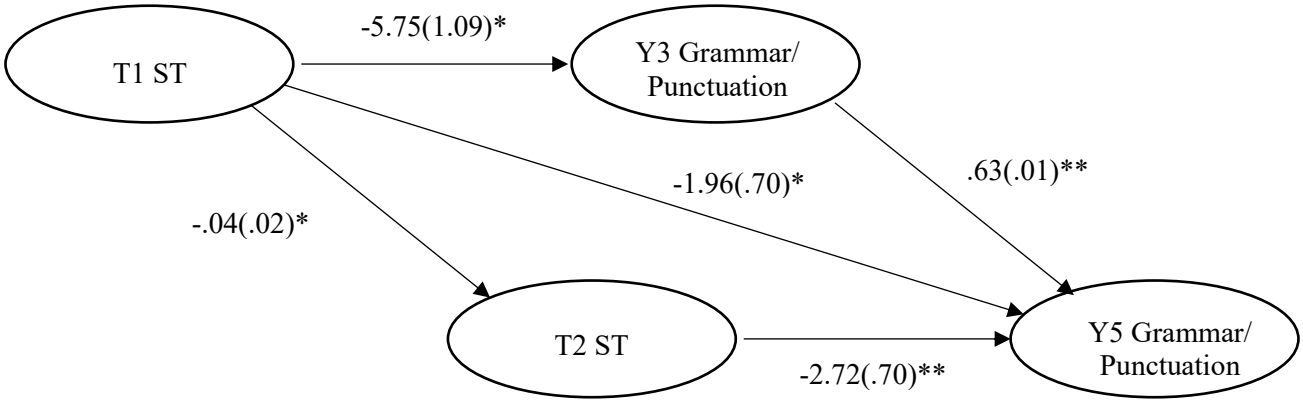

Figure 5. Model 5: Direct effects of screen time and NAPLAN grammar/punctuation scores. Numbers represent unstandardized coefficients (standard error); T1 ST = screen time collected at first time point; T2 ST = screen time collected at second time point; Y3 = Year 3; Y5 = Year 5.
Note: Error terms have been omitted for clarity of presentation.
*p < .01; **p < .001.

Discussion

In the first hypothesis, it was proposed that higher levels of ST will significantly predict a medium-term effect on academic achievement (i.e. a change across approximately 3-5 years). These results showed that ST at T1 demonstrated a significant negative association with Year 3 NAPLAN scores in all five domains including reading, writing, numeracy, spelling and grammar/punctuation. However, only one medium-term effect was observed between ST at T2 and Year 5 NAPLAN. That is, ST at T2 demonstrated a significant negative association with Year 5 NAPLAN scores in grammar/punctuation.

The second hypothesis, that greater ST would significantly predict a long-term effect on academic achievement (i.e. a change across 5-7 years), was supported by the results of this study. Indeed, ST at T1 predicted lower scores on the Year 5 NAPLAN in reading, writing, and grammar/punctuation however this effect was not observed for numeracy and spelling. Taken together, these results illustrate that more ST leads to a decreased performance in academic achievement across time, although not across all NAPLAN-measured domains.

There has been a great deal of interest in the literature regarding the effects of ST on long-term outcomes, particularly towards children's academic learning. Overall, these findings support previous cross-sectional literature such that increased ST leads to poor

academic achievement (Aguilar et al., 2015; Howie et al., 2020; Sharif & Sargent, 2006). These studies collected data on ST during primary or middle school, whereas the current study collected data on ST during when children begin to enter school and again during primary school. This is particularly important as children are now accessing ST at an earlier age (Rideout, 2013) and are highly malleable during these sensitive developmental periods (Thomas & Knowland, 2009).

This study also showed support for longitudinal research of adolescent samples (Johnson et al., 2007; Nelson et al., 2006; Poulain, Peschel, et al., 2018) and a prospective study by Anderson et al. (2001) who also collected data on early ST use and grades in English, science and mathematics. This suggests that effects of ST on academic achievement, starts not only in the adolescent years but as young as 4-5 years old, and attention to these habits need to start in the early years of childhood. Although Anderson et al. (2001) collected data on various subjects, they did not analyse these separately. The present research was able to separate domains of academic achievement in order to provide a more comprehensive account of the differences between associations. One potential explanation for the lack of persistence of long-term associations between domains is that children vary in their rate of acquisition of literacy and numeracy skills and this is dependent on a combination of genes and environmental factors. Specifically, Grasby and Coventry (2016) found that the growth pattern across time for reading has been accounted largely by genes, whereas other literacy domains (i.e. writing, spelling, grammar/punctuation) were due to environmental factors, such as different schools or teachers, and numeracy was mixture of both. Moreover, most of these previous studies have used school grades as a measure of academic achievement, comparative to the current study that utilised a standardised and compulsory measure across educational institutions.

A strength of the current study is the use of the NAPLAN, which is the most widely accepted standardised measure for academic achievement across educational institutions (Rose et al., 2018). A strength of this study is that NAPLAN was utilised in such a way as to obtain a measure of performance across a diverse range of skills, such as reading, writing, numeracy, spelling and grammar/punctuation (Australian Curriculum Assessment and Reporting Authority, 2013). The NAPLAN provides data on student and school performance, as well as a nationwide performance on academic learning. An equating process, occurring both on-shore and off-shore (i.e. in Australia and New Zealand) was employed for the NAPLAN in order to ensure that testing from the current year can be modified to the same level of difficulty as the previous year (Australian Curriculum Assessment and Reporting Authority, 2010). This process ensures the reliability of the NAPLAN which was developed following guidance from an expert advisory group in educational measurements. In addition, routine methods have been utilised to estimate the reliability of tests (Australian Curriculum Assessment and Reporting Authority, 2010).

There remains ambiguity as to whether ST increases or decreases academic achievement. Although these results demonstrate some support for medium-term effects of ST on academic achievement, ST was not categorised into recreational and educational purposes, and represents a limitation of the current study. Previous studies have argued that the content of ST may explain discrepant findings, which was also not captured and assessed in these studies (Jackson et al., 2011; Munasib & Bhattacharya, 2010; Syväoja et al., 2013). As mentioned by Kirkorian et al. (2008), ST that facilitates learning can have positive outcomes for children regarding academic achievement. Although ST may have detrimental consequences on academic success and development, it also has the potential to be a valuable learning tool if the content and context of ST is considered.

Further limitations of the current study should be considered. One is that the NAPLAN provides an annual review of student academic achievement, and thus it does not give a detailed portfolio of achievement progress across time particularly changes within the year (Cumming & Dickson, 2013). It also does not report growth at the classroom level (Gonski et al., 2018). Despite this limitation, this study aimed to examine longer-term changes and included two time points to provide detail of learning across this timeframe. Another limitation is that due to the longitudinal nature of the study and the use of the NAPLAN data, this study did not consider handheld forms of ST such as smartphones, iPads/tablets and other devices, which have recently grown popular within the past decade. Lastly, this study was limited to measuring only ST and thus it could not account for factors such as content and context of use that may have influenced the findings. Specifically, viewing educational content may lead to more beneficial outcomes than purely viewing recreational content.

As the world becomes more technologically advanced, it is imperative that we understand the benefits and risks associated with the amount of ST experienced by children, particularly how it may impact on children's development. The current study has identified that ST for children that enter and transition into primary school, a sensitive period for growth and learning, has implications for academic achievement. In particular, more hours spent on ST leads to a decreased performance in academic achievement across time, however this was not present in all NAPLAN measured domains. The use of screens has become more salient in educational settings, particularly with the introduction of handheld devices. It is worthwhile for future studies to examine the effects of handheld devices on academic achievement, especially given their increasing prevalence among young children. Future studies could consider genetic and environmental factors, as well as utilise multiple measures of academic achievement, such as school grades and cognitive tests, to increase the validity

and strength of results. Moreover, the COVID-19 pandemic has resulted in more uptake of online learning for children and longer periods looking at information on screens, concomitantly increasing overall sedentary behaviour. Future directions of studies may need to look towards studying the impacts of the pandemic on academic achievement based on any reported increases in ST behaviours.

Prelude to Chapter Three

Chapter Two demonstrated findings related to traditional forms of ST. While it is anticipated that findings on handheld devices will be consistent with those for traditional forms of screens, potential differences may arise due to the portability, accessibility and functionality of handheld devices for young children, and their increasing preference for such devices.

The upcoming chapter will present a systematic review of the literature relating to children aged up to eight years old, published between 2009-21. This systematic review sought to examine the parental characteristics associated with child handheld ST, and how these impact on social, emotional and behavioural developmental outcomes in children.

CHAPTER 3: Parental Characteristics, Handheld Screen Time and Developmental Outcomes: A Systematic Review

Parental Characteristics, Handheld Screen Time and Developmental Outcomes: A Systematic Review

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Abstract

Child handheld screen time (CHST) has become increasingly popular and accessible activity and refers to engagement with the use of smartphones, tablets, iPads, eBook readers or similar devices. The aim of this review was to examine the evidence for parental characteristics associated with CHST, and explore how this affects social, emotional and behavioural developmental outcomes in children. A systematic review of peer-reviewed articles examining children aged 0-8 years and published between 2009-2021 was undertaken. Twenty studies met inclusion criteria, where 15 of which examined parental characteristics and five studies investigated developmental outcomes. This review found that increased CHST was associated with more positive attitudes and behaviours about screen use, greater parental limit-setting, decreased parental self-efficacy and poorer wellbeing, lack of availability and permissive parenting styles. Most studies reported an association between CHST and poorer developmental outcomes; however, results should be interpreted with caution given the limited number of studies. Future research should increasingly examine the longitudinal effects of CHST for developmental outcomes, the role of parental wellbeing in CHST, and consider the methodological issues identified in this review.

Keywords: Handheld device, screen time, parental characteristics, child, development

Introduction

Over the past decade, child handheld screen time (CHST) among children aged 0-8 years old has grown exponentially (Rideout, 2013). Screen time (ST) refers to the time spent on electronic media for a wide range of purposes, including social networking, learning, creativity, self-expression, playing games and entertainment (Yu & Baxter, 2016). ST can be categorised into two domains: CHST that includes the use of smartphones, tablets, iPads, eBook readers or similar devices, and traditional ST (TST), referring to television (TV), gaming consoles and computers. Health experts have noted the importance of limiting ST for children as a passive activity (American Academy of Pediatrics, 2016a). However, the digital revolution, as well as the restrictions imposed by COVID-19, have increased the use of screens by children for education. Research has identified that active engagement with screens rather than passive viewing may have positive implications for child development. For example, physically active screen games have shown improved academic performance, decreased negative classroom behaviours, and a motivator for children to exercise (Lieberman et al., 2011). In addition, parents who co-view with their child have shown increased quality in parent-child interactions and further benefits for their social development (Connell et al., 2015).

Health experts have advised that ST should be moderated for children and be proportional to their age and stage of development (American Academy of Pediatrics, 2016a). The guidelines from American Academy of Pediatrics (2016a) recommend children under two should not engage in any ST, preschool children should limit overall ST to a maximum of one hour per day, and children over six years old should engage in no more than two hours of ST per day. These guidelines also detail appropriate activities/content viewed, distinguishing between active vs. passive screen use, and outline conditions for co-viewing between parents and their children. More recent guidelines from the 24-Hour Movement from

Australia, New Zealand and South Africa, based on Canadian Guidelines, present similar recommendations to those from the American Academy of Pediatrics (Australian Department of Health, 2019; Tremblay, 2020).

Research has demonstrated that a majority of children surpass these recommended levels of use (Houghton et al., 2015). Although TV remains the most commonly used screen in children's lives, the popularity of handheld devices continues to grow. A 2019 survey of US children found that by age 12, approximately 70% of children had their own smartphone (Rideout & Robb, 2019). In an Australian Child Health Poll, it was reported that 17% of children aged under two years and 36% of children aged between 3-5 years owned their own tablet or smartphone (Rhodes, 2017). Growing evidence suggests that parents play a pivotal role in CHST (Samaha & Hawi, 2017), and this may influence outcomes for children's social, emotional, and behavioural development (Wu et al., 2017). In our review, developmental outcomes refers to social, emotional and behavioural development including features of child development, such as prosocial skills, emotional expression, self-regulation, and hyperactivity (Hammer et al., 2018).

Parental Characteristics and Screen Time

Social learning theory proposes that behaviour is learnt from observing and imitating others' actions (Bandura, 1977). As children depend heavily on their parents in the early years, parents act key drivers of the establishment and maintenance of children's habits and behaviours through modelling behaviour to children (Lauricella et al., 2015). Research pertaining to TST has demonstrated the importance of parental characteristics on the development of screen-related habits (Jago et al., 2015; Lauricella et al., 2015). We refer to parental characteristics as a set of parental attitudes, behaviours, or practices that may influence ST habits in children (Samaha & Hawi, 2017). In comparison to TST, children may

now observe their parents accessing multiple devices across several contexts given their portability (Lauricella et al., 2015). With increased access to devices may mean that more children are engaging in greater CHST.

Consistent with bioecological theory (Bronfenbrenner, 1979), child development is facilitated by a number of concentric environmental systems. Commencing with the microsystem, which has the most influence on a child, such as family, peers and school, and then moving towards the macrosystem, which include the wider community and culture. Certain influences may have a larger effect on child development, given their presence, frequency and significance to the child, namely the family. Lauricella et al. (2015) suggested that parental screen behaviours were seen as ongoing, and therefore children are constantly exposed to such behaviours, and use devices to interact with their parents and others in the environment. Therefore, the consideration of parental characteristics is essential in informing our understanding of children's screen use and its influence on their developmental outcomes.

Evidence suggests a range of parental characteristics may contribute towards increased screen use. However, current systematic reviews from the field represent some limitations. Xu et al. (2015) solely examined TST in their review of 30 cross-sectional studies and reported mixed evidence between correlates. Within this review, several studies found associations for parental self-efficacy and parental ST with child ST, however mixed evidence was observed for parenting practices, parental attitudes and parenting style with child ST. Other reviews have failed to distinguish between CHST and TST (Duch et al., 2013; Hoyos Cillero & Jago, 2010), and therefore specific data to handheld devices may not be distinguishable. Paudel et al. (2017) attempted to address this limitation in their review by examining studies, of CHST separately to TST. While this represented a significant advance in the literature, the review was limited by its focus on cross-sectional research, which cannot

capture crucial changes across the developmental trajectory. The current review will aim to provide a comprehensive account of various parental characteristics associated with and unique to handheld devices. As the current generation of children have now only ever lived in a world characterised by the presence of handheld devices, and therefore the implications for children's developmental outcomes warrants attention.

Screen Time and Developmental Outcomes

Children's brains respond to environmental stimuli and develop more quickly during the first years of life than any other point across the lifespan (Cohen, 2015). The limbic regions of a toddler's brain develop faster than prefrontal regions, which function to modulate arousal. When parents use devices to regulate arousal, this may inadvertently increase CHST and inhibit children's ability to develop self-regulation. As children enter their preschool years, rapid changes occur in their physical development, motor and language development, world view, play and capacity to socialise (Cohen, 2015). Passive use of devices may potentially displace interpersonal and physical interaction, and thus affect the acquisition of social skills. However, when used in active engagement, they may facilitate interpersonal communication and information sharing with others; allow children to access interactive games, stories, or music; and provide exposure to stimuli that they may be unable to physically see (Kai Yee et al., 2019). Nevertheless, there appears to be scope to explore the effects of CHST on the implications for developmental outcomes, especially considering the rapid changes in the early years of life.

To date, most of the research exploring the developmental implications of children's ST has focused on TST (Gingold et al., 2013; Page et al., 2010) or the consideration of ST in general terms (Sanders et al., 2016). Numerous studies have demonstrated greater levels of TST has been associated with negative implications for development, such as increased sedentary behaviour; poorer measures of physical and mental health; and reduced

neurophysiological development (Gingold et al., 2013; Page et al., 2010). Greater TV and computer use has further been found to be associated with reduced prosocial behaviour, emotional dysregulation, peer difficulties and hyperactivity in children (Page et al., 2010). It is noteworthy that Page et al. (2010) found these effects irrespective of the child's level of physical activity. Similar results were identified in a longitudinal study conducted by Parkes et al. (2011), further highlighting the potential developmental implications of ST on children over time.

There is some evidence to suggest that higher levels of CHST may be associated with developmental problems similar to those demonstrated in relation to the increased use of TST. For instance, Wu et al. (2017) found that greater CHST was related to higher levels of emotional symptoms, conduct problems, hyperactivity, and peer problems, and reduced prosocial behaviour. In a prospective study of children aged 7-11 years old, it was concluded that heavy mobile users may become inattentive and unable to filter out irrelevant environmental stimuli, and this may result in changes in their social interactions (e.g. less attentive to peers) and behavioural development (Sudan et al., 2016). Additionally, children who experience anxiety may use screens as a form of avoidance to alleviate the discomfort associated with interpersonal peer interaction, thus minimising opportunities to develop social competence (Kley et al., 2012). A systematic review of children under five concluded that greater CHST was associated with risks of peer relation problems, inattention, aggression and temperamental concerns (Rocha & Nunes, 2020). While informative, this review was limited such that conclusions regarding handheld devices were considered in a clustered format, where some articles did not isolate ST into handheld or traditional forms. Given the increasing prominence of and preference for CHST over TST in children's lives, additional reviews of the literature that seek to better isolate the further effects of handheld devices on developmental outcomes in children are warranted.

Aims of Review

It is well acknowledged that parents form the foundation for children's screen habits and behaviours and may lead to consequences for the developmental outcomes for children. Negative developmental outcomes have been associated with children's ST (Sudan et al., 2016; Wu et al., 2017), however specific social, emotional, and behavioural consequences have not been distinguished. A limited number of reviews have solely considered handheld devices rather than joining data with TST, particularly as this type of screen differs in their interactivity, portability and accessibility compared to TST. There has also been a lack of focus on longitudinal studies that may explain the effects of parental characteristics across the trajectory of children's development. Therefore, the aim of this review was to examine the evidence for parental characteristics associated with CHST, and explore how this affects social, emotional and behavioural developmental outcomes in children.

Method

This review followed the PRISMA guidelines (Moher et al., 2015) and the protocol was registered with PROSPERO [CRD42017074892].

Inclusion and Exclusion Criteria

Inclusion criteria: Studies that pertained to CHST; considered parental characteristics or child developmental outcomes; consisted of community samples of children aged up to eight years from any country; were longitudinal or cross-sectional peer-reviewed articles; in the English language; and published between 1 January 2009 and 2 February 2021. This timeframe was determined on the basis that CHST increased and was available by 2009 with the advent of iPads/tablets.

Exclusion criteria: Studies that included children over the age of eight years old; when CHST could not be extracted from findings of TST; findings that did not consider parental

characteristics or children's developmental outcomes; when social, emotional and behavioural outcomes could not be solely extracted from findings that included other developmental domains (e.g. physical development); systematic reviews, meta-analyses and opinion-based reviews; or participants of atypical development (e.g. neurodevelopmental disorders).

Search Strategy

Articles were identified through a systematic search of the following electronic databases: PsycINFO, Scopus, Web of Science Core Collection, EMBASE, CINAHL and PubMed. This search was conducted in February 2021. Search parameters included articles published in peer-reviewed journals in English from January 2009 to February 2021. Search terms included variants of 'family', 'screen' and 'development' to meet the requirements of individual databases. See Supplementary Table 1 in Appendix E for search terms used in databases. Studies were retrieved based on a title and keyword search. Moreover, the reference lists of selected studies and other potential grey literature sources were reviewed to include potential additional studies not captured by the initial search strategy.

Study Selection

Figure 1 represents the PRISMA flow chart. A total of *n*=3972 records were identified through database searches, with an additional *n*=4 articles retrieved from other sources (*n*=3976). Of these, *n*=915 were identified as duplicates and removed and a further *n*=2779 were excluded during title and abstract screening. This resulted in *n*=125 articles available for full-text review by two independent raters. Following full-text review, *n*=20 articles were retained and included in the final analysis. Finally, these studies were subjected to an assessment of interrater reliability. Cohen's Kappa statistic of 0.84 was achieved (71.43%), after which disagreements between raters were resolved through discussion.

Assessment of Methodological Quality

The methodological quality of eligible articles was assessed using a modified version of the Downs and Black (1998) checklist. This modified checklist contains 10 items and has been used in previous systematic reviews investigating ST (Duch et al., 2013; Paudel et al., 2017; Vanderloo, 2014). Domains included reporting, external validity, and internal validity bias. Studies were assessed against these criteria and a score of 10 was possible, with a score of more than five was indicative of an acceptable level of bias. The assessment of methodological quality was conducted by two independent reviewers (N.B. and S.B.). All studies achieved an acceptable level of bias and were retained in the review.

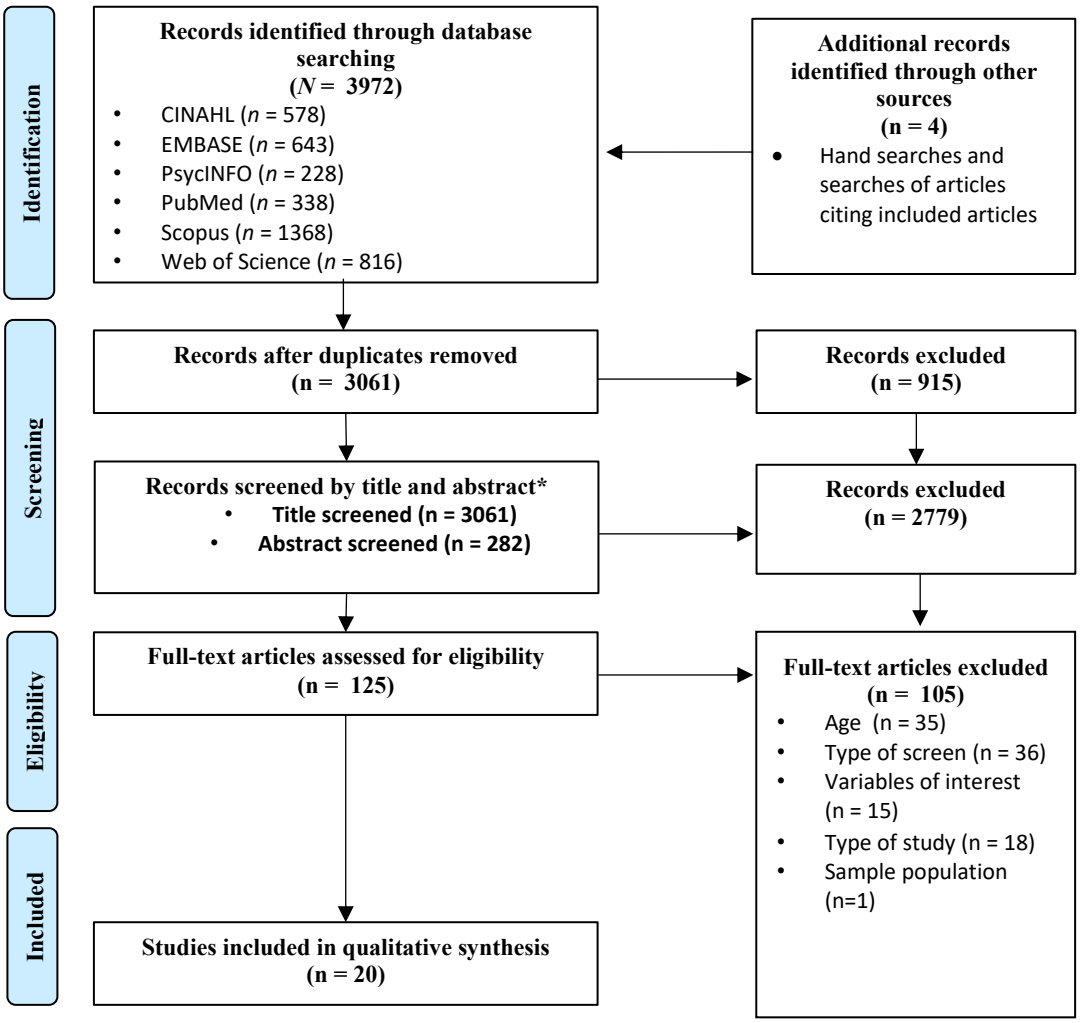

Figure 1. PRISMA flow diagram outlining the study selection process

Results

Characteristics of the included studies are summarised in Table 1. Twenty studies were retained for inclusion in the review. Included studies were published between 2013 and 2020, and from ten countries. Most of the included studies (90%) were cross-sectional, while two studies were longitudinal. Sixteen out of 20 studies (80%) administered questionnaires to parents, and four studies (20%) conducted individual interviews with parents. Six out of 20 studies (30%) solely investigated CHST, whereas 14 studies (70%) examined CHST in addition to other technological devices. Sample sizes for the included studies ranged from N=9 to N=5000 participants. All studies consisted of parent-child dyads, with five studies (25%) collecting data from mother-child pairs. Participants were from varying socioeconomic statuses and recruited from diverse locations. All studies reported the age range of child participants (0-8 years old). There was an approximately equal representation of child gender in seven studies (percentage of girls ranged from 46%-55%), however girls were underrepresented in four studies (37%-44%). Five studies did not report on gender.

Overview of Main Findings

Table 1 presents a summary of these findings.

Parental Characteristics

Higher levels of parental ST was found to lead to greater CHST in five studies (Connell et al., 2015; Lauricella et al., 2015; McDaniel & Radesky, 2018; Myruski et al., 2017; Nikken & Schols, 2015). These studies reported similar findings and were also comparable in that they sampled both older and younger children, and findings were based on quantitative data. Connell et al. (2015) uniquely explored this association in the context of parent-child co-use of screens and found that parental ST was a significant predictor of parent-child co-use of handheld devices. In particular, parents who used screens more tended

to have positive attitudes towards CHST, and thus were more likely to instruct their children regarding use of screens (Connell et al., 2015). Importantly, when parents engaged in greater handheld ST, it resulted in a phenomenon termed *technoference.* This referred to disruptions in daily interactions between a parent and child due to technology (McDaniel & Radesky, 2018).

Eleven studies showed that more positive attitudes towards CHST was associated with higher levels of CHST (Baek et al., 2013; Bentley et al., 2016; Brown & Smolenaers, 2018; Guedes et al., 2020; Kabali et al., 2015; Kulakci-Altintas, 2019; Lauricella et al., 2015; McCloskey et al., 2018; Nikken & Schols, 2015; Seo & Lee, 2017; Solomon-Moore et al., 2017). However, Nikken and Schols (2015) did not report such an association. Despite methodological differences between studies, the majority of studies reported that more positive parental attitudes towards ST were associated with greater CHST.

Negative attitudes towards CHST also impacted parental limit-setting of CHST. Parents who held concerns about the potential risks of CHST were more likely to apply restrictions regarding content and use, and supervise their child's screen use (Nikken & Schols, 2015). These negative attitudes towards CHST included beliefs about the adverse effects of CHST on child development; and more specifically, exposure to harmful content, increased sedentary behaviour, and concern about the potentially addictive nature of CHST (Baek et al., 2013; Bentley et al., 2016). Interestingly, McCloskey et al. (2018) reported that holding negative beliefs about CHST tended to be more likely among parents with higher education status.

Two studies found that parents were more likely to implement limits for children who engaged in high CHST due to their concerns around such usage (Kesten et al., 2015; Nikken & Schols, 2015). Seo and Lee (2017) observed that parents granted use of devices as a method of rewarding or punishing child behavior. In contrast, Solomon-Moore et al. (2017)

concluded that increased parental limit-setting was associated with lower levels of CHST. Moreover, three studies found decreased parental self-efficacy was associated with greater CHST (Baek et al., 2013; Chen et al., 2020; Solomon-Moore et al., 2017).

Finally, other parental characteristics have also been considered, where decreased parental wellbeing (e.g. role overload, relationship dissatisfaction) and increased parental anxiety was associated with higher levels of CHST. Parental anxiety also seemed closely tied to negative perceptions about CHST (Seo & Lee, 2017). CHST also increased when parents were less available to their children (Solomon-Moore et al., 2017) or demonstrated permissive parenting styles (Connell et al., 2015).

Developmental Outcomes

The relationship between CHST and children's developmental outcomes was investigated in five studies (Cerniglia et al., 2021; Cho & Lee, 2017; Gülay Ogelman et al., 2018; McDaniel & Radesky, 2018; Poulain, Vogel, et al., 2018b). On balance, the studies indicated that greater CHST was associated with a range of greater developmental difficulties. For example, Cho and Lee (2017) found that children engaged in excessive smartphone use was associated with increased aggression, hyperactivity, and withdrawal; decreased emotional intelligence, peer interaction, and physical activities; and adversely influenced social skills and emotional regulation. McDaniel and Radesky (2018) concluded that technoference was also related to greater child internalising and externalising problem behaviours. There was evidence to indicate that high CHST was associated with higher levels of hyperactivity, inattention, conduct problems and overall difficulties in childhood (Poulain, Vogel, et al., 2018b). Cerniglia et al. (2021) also identified that high CHST was associated with greater emotional dysregulation at both time points across a two-wave four year longitudinal study. In contrast, Gülay Ogelman et al. (2018) found that mobile devices did not seem to affect children's attainment of social skills.

Table 1

Characteristics of eligible studies

Author, (Year), Country	Study Design, Method	Sample size, population, age range, recruitment method, gender	Outcome Measure	Type of Screen	Predictor	Child Screen Use	Main Findings
Baek et al., (2013), South Korea	Cross-sectional, Self-report survey	*N* = 500; MCD; 0-6 years; CEI; 53.7% M, 46.3% F	CHST	MP	Parental efficacy & PA	57.9% used MP daily: 75% used ST for 1hr; 35% used >2hrs	MR reasons for CHST: learning (47.7%), follow trends (42.2%), distraction (27.3%), reduce fear of ST (18.8%). MR reasons against CHST: electro-magnetic waves & visual disability (77.6%), harmful websites (26.2%), undermines cognitive (36.7%), social (30.4%), physical (18.2%) & brain (14.3%) development, respectively. Conditions where ST occurs: child preference (51.7%), busy lifestyle (28.1%), soothe children, (11.3%), learning (11.3%), video communication (4.1%). PC: ↓Parental cognitive & emotional self-efficacy, ↑Parental skilful roles, problem-solving capacity, & positive identity about parental role.
Bentley et al., (2016), United Kingdom	Cross-sectional, Interviews	*N* = 26; MCD; 2-4 years; CEI, nurseries, & mother-toddler groups; 62.1% M, 37.9% F	CHST	TV, COM, CON, MP & TAB	PA & influences of CHST	NR	MA towards CHST: educational; acceptance in moderation; behaviour management tool; skill acquisition; concerns about content and addiction, sedentary behaviour, social development, & child screen desirability. MR to use CHST: Positive (↓child passivity & required engagement in activities) & negative (solitary activity, affect social development. PC: restrictions, fathers' encouragement of use, & mothers' childhood experience of ST.
Cerniglia et al., (2020), Italy	Longitudinal study, Self-report survey	*N* = 356; MCD; 4 years; Community-based study; 48% M, 52% F	Emotion regulation & academic achievement	MP, TAB & iPa	CHST	Average daily use of CHST 1.5hrs at baseline	↑CHST → ↑Maternal involvement in activities ↑CHST at baseline → ↑Dysregulation at both time points. Dysregulation at first time point mediated the relationship between ↑CHST at baseline and ↓mathematics grades at second time point.
Chen et al., (2020), China	Cross-sectional, Self-report survey	*N* = 4907; PCD; 3-6 years; CEI; 52.9% M, 47.1% F	CHST	TV, MP, TAB, iPa & COMP	Parental efficacy	Average daily use of CHST 1.1hrs	Parents of low SES more likely to report low efficacy. PC: Parental efficacy negatively associated with CHST

Author (Year), Country	Study Design, Method	Sample size, population, age range, recruitment method, gender	Outcome Measure	Type of Screen	Predictor	Child Screen Use	Main Findings
Cho & Lee, (2017), South Korea	Cross-sectional, Self-report survey	*N* = 303; PCD; 1-6 years; CEI; 50.8% M, 49.2% F	CB & EI	MP	CHST	NR	PC: In their 20s, lack stable jobs & less than a high school degree. ↑CHST → ↑ Problematic behaviours, ↓peer interactions peers, ↓EI, ↓ physical activities & ↑difficulties with social skills & emotional control. PR reasons for CHST: amusement & educational value.
Connell et al., (2015), USA	Cross-sectional, Self-report survey	*N* = 2326; PCD; 0-8 years; GfK's online panel; 50% M, 50% F	PCHST	TV, COMP, CON, TAB, & MP	PST & availability	25% used TAB & 21% used MP	>50% of parents co-used MPs (63%) & TAB (64%) with their children 'all', 'most of the time' or 'some of the time'. PC: Lack of availability, older in age (co-use tablets), younger in age (co-use phones), & ↑PST.
Guedes et al., (2020), Brazil	Cross-sectional, Self-report survey	*N* = 244; PCD; 24-47 months; CEI; 49.2% M, 50.8% F	CHST	MOB & TAB	Conditions allow for CHST	Average daily use of CHST 1.2hrs	PR reasons for CHST: Distract in public (15.3%), distract at home (50.9%) & to stimulate development (59.5%). PR: 86.4% set limits for CHST & 75.2% co-use with child.
Gülay et al., (2018), Turkey	Cross-sectional, Self-report survey	*N* = 162; PCD; 5-6 years; CEI; 56.2% M, 43.8% F	SS	TV, COMP, TAB & MP	CHST	NR	↑CHST did not predict SS.
Kabali et al., (2015), USA	Cross-sectional, Self-report survey	*N* = 350; PCD; 6 months-4 years; paediatric practice in low SES; 48.1% M, 51.9% F	CHST	TV, COMP, CON, TAB/iPA, & MP	Conditions allow for CHST	99.6% used MP; 83% owned TAB; 77% owned MP	PR reasons to allow CHST: Chores (70%), calm child in public (65%), or run errands (58%), & put child to sleep (28%). ↑Child's age → ↑CHST.
Kesten et al., (2015), United Kingdom	Cross-sectional, Self-report survey	*N* = 735; MCD; 6-8 years; online parenting organisation; 46.7% M, 41.8% F	CHST	TV, COMP, CON, & MP	PLS	NR	>50% PR 'always or sometimes' setting limits for CHST, with highest proportion (32.14%) for 'not applicable' setting limits was CHST compared to other devices. 'Always' setting limits category → ↑CHST in girls. No evidence was found for the association between 'sometimes' limit setting & MP.

Author (Year), Country	Study Design, Method	Sample size, population, age range, recruitment method, gender	Outcome Measure	Type of Screen	Predictor	Child Screen Use	Main Findings
Kulakci-Altintas, (2019), Turkey	Cross-sectional, Self-report survey	*N* = 500; PCD; 0-3 years; family health centre; NR	CHST	TV, MP, TAB, iPa & COMP	Conditions allow for CHST	For MP, 56.3% use <1hr daily; 43.7% use 2-5 hrs daily. For TAB/COMP, 43.8% use <1hr daily; 56.2% use 2-5 hrs daily.	81.8% allowed CHST. PR reasons to allow MP: Calm child (32.3%), put child to sleep (20.4%), doing housework (20.4%), while child was eating food (19.8%), when child spoiled (4.8%), and to spend time with friends (2.4%). PR reasons to allow TAB/COMP: while child was eating food (42.5%), when child cried (26.3%), while doing housework (22.5%), put child to sleep (6.2%) and when child spoiled (2.5%).
Lauricella et al., (2015), USA	Cross-sectional, Self-report survey	*N* = 2400; PCD; 0-8 years; GfK's online panel; 50% M, 50% F	CHST	TV, COMP, MP & TAB	PST & PA	15min used daily for MP & 29min used daily for TAB	↑PST → ↑CHST (MPs) in the 2-5 & 6-8 year old groups. ↑PST → ↑CHST (TAB) in all age groups. ↑Positive PA → ↑CHST (TAB) in preschool & older children.
McCloskey et al., (2018), USA	Cross-sectional, Self-report survey	*N* = 192; PCD; 3-5 years; CEI from rural, low SES; 61% M, 39% F	CHST	MP, CON & TAB	PA & comfort with screens	92% used MP or TAB; Almost 75% used device daily or occasionally	PC: Parental education, ethnicity, & parents' own comfort using screens. Hispanic parents: ↑PCST to monitor content & ↓PCST because the parent enjoyed it.
McDaniel & Radesky, (2018), USA	Cross-sectional, Self-report survey	*N* = 183; PCD; 0-5 years; Family research database, parenting websites, listservs & local community; 45% M, 55% F	CIEB	TV, COMP, CON MP, TAB, & iPo	PST	NR	↑ Problematic PST → ↑Technoference In fathers, ↑ perceived PST → ↑ internalising behaviour, ↑CST, ↑income & ↑parenting stress. In mothers, ↑perceived PST → ↑technoference. For both, ↑Technoference → ↑Child internalising & ↑CST MR: ↑Technoference → ↑ Externalising behaviour FR: ↑Technoference → ↓Perceptions of co-parenting ,↑ Parental depressive symptoms & ↑ Parenting stress.

Author (Year), Country	Study Design, Method	Sample size, population, age range (M, SD), recruitment method, gender	Outcome Measure	Type of Screen	Predictor	Child Screen Use	Main Findings
Nikken & Schols, (2015), Netherlands	Cross-sectional, Self-report survey	*N* = 896, PCD; 0-7 years; Dutch online panel; 50% M, 50% F	CHST	TV, CON, COMP, & OTH	PST, PA & PLS	NR	PA was not strongly associated with CHST. ↑Device ownership in the bedroom → ↑CHST. ↓Parental education → ↑ Ownership of screens in bedroom. ↑PST → ↑CHST. PA are predictors of PLS, where 1) media functions as a pacifier → ↑restrictions, 2) media is too complex for children → ↓Supervision & co-use, & ↑Restrictions.
Pempek & McDaniel, (2016), USA	Cross-sectional, Self-report survey	*N* = 358, MCD; 12-48 months; Community announcements in buildings & parenting website; NR	CHST	TAB	Parental wellbeing	NR	↑CHST → ↓Personal wellbeing (i.e. role overload, depressive symptoms) & ↓relational wellbeing (relationship satisfaction, co-parenting, conflict) in mothers. ↑CHST → ↑PST. Mother's age & income not associated with CHST.
Poulain et al., (2018), Germany	Longitudinal, Self-report survey	*N* = 527, PCD; 2-6 years; Hospitals & public health centres; 51.61% M, 48.39% F	BD	TV, CON, COMP & MP	CHST	4% used MP at baseline, & 5% used MP at FU	↑CHST → ↑Total difficulties & hyperactivity/inattention at FU. ↑CHST → ↑Conduct problems at baseline.
Seo & Lee, (2017), USA	Cross-sectional, Ethnographic interviews	*N* = 20 PCD; 2-6 years; Researcher's social networks; NR	CHST	TAB, MP & OTH	PA, PLS, & anxiety	NR	Negative PA: 1) psychological problems (e.g. compulsive use), 2) physical effects (e.g. eyesight & posture), & 3) cognitive development (e.g. passive viewing). ↑Parental anxiety about CHST was due to: ↑negative PA about attachment to CHST & lack of evidence towards ST. ↑Passive PA of negative effects of CHST → ↑PLS (i.e. restrictive vs. reward/punishment). CHST occurred almost daily & functioned as a babysitter. CHST → ↑Parental guilt.
Solomon-Moore et al., (2017), United Kingdom	Cross-sectional, Self-report survey & physical exercise device	*N* = 1267; PCD; 5-6 years; CEI; NR	CHST	TV, COMP, CON, TAB & MP	PA, PLS, efficacy, styles & modelling	4.5% >2hrs weekday use; 7.1% >2hrs weekend use	↑Negative PA & PLS → ↓CHST. ↑Parental self-efficacy for mediation practices → ↓CHST. ↑Permissive parenting styles → ↑CHST.

Note: ↑ = Increase; ↓ = Decrease; → = Associated with; BD = Behavioural difficulties; CB = Children's behaviour; CEI = Child education institutes (e.g. daycare, preschools, kindergartens, primary school and other learning institutes); CIEB = Child internalising and externalising behaviour; COMP = Computers; CON = Consoles; CHST = Children's handheld screen time; ED = Emotional difficulties; EI = Emotional intelligence; FR = Father reported; FU = Follow-up; iPa = iPads; iPo = iPods; MA = Mother's attitudes; MCD = Mother-child dyads; MP = Mobile phones; MR = Mother reported; NR = Not reported; OTH = Other media devices; PA = Parental attitudes; PCD = Parent-child dyads; PC = Parental characteristics associated with increased children's screen time; PCHST = Parent-child co-use of handheld screen time; PR = Parent reported; PLS = Parental limit setting; PST = Parental screen time; SS = Social skills; ST = screen time; TAB = Tablets; TV = Television.

Discussion

This systematic review identified twenty studies published between 2013 and 2020 that explored CHST in children aged 0-8 years that met inclusion criteria. Fifteen of these studies focused on parental characteristics and five studies investigated the effects of CHST on developmental outcomes in children.

Parental Characteristics

In the fifteen studies that focused on parental characteristics, some reported one or more parental characteristics associated with greater CHST. These included: greater parental ST, positive attitudes towards CHST, decreased limit-setting and parental self-efficacy to set limits, decreased parental wellbeing and increased parental anxiety, less parental availability and permissive parenting styles. These results reflected similar results from previous systematic reviews that included both TST and CHST and therefore reinforcing the robustness of these results (Duch et al., 2013; Hoyos Cillero & Jago, 2010; Xu et al., 2015). The majority of studies focussed on the impact of parental ST, parental attitudes, and parental limit-setting of ST suggesting that these characteristics are among the strongest predictors of CHST (Jago et al., 2013; Lauricella et al., 2015). Specifically, parents held certain attitudes regarding device usage which affects their own ST behaviours, and the type of limits implemented for their children. Mixed evidence in comparison to previous literature was observed for parental limit-setting. Previous research demonstrated that structured rules and limits were effective in minimising CHST (Thompson et al., 2017), however current evidence suggests that given CHST has increased among children, and this has raised concerns for parents to engage in more limit-setting (Kesten et al., 2015; Nikken & Schols, 2015). These findings reinforce the level of influence parents have for setting and establishing early screen habits within this age cohort, given their developmental vulnerability.

Collectively among the studies, some parental characteristics were associated with one another. For example, parents who had attitudes of concern regarding CHST had a greater likelihood of applying limit-setting, and parents who had increased self-efficacy to set limits were more likely to do so, and thus affecting the rate of CHST (Nikken & Schols, 2015; Solomon-Moore et al., 2017). Parental anxiety may also be related to parental limit-setting surrounding CHST such that parents may have difficulty setting rules for their child's ST due to their own anxiety about ST. Parents reported being anxious about their child viewing inappropriate content, ST addiction, decreasing physical activities and its effect on their child's development (Seo & Lee, 2017). Moreover, parents who were more available were more likely involved in their child's screen use, through discussing the material viewed, and applying limits on content and amount of ST (Connell et al., 2015). In contrast, permissive parents were less likely to limit their child's ST, as they were unwilling to reduce their own ST or did not have attitudes of concern regarding ST (Solomon-Moore et al., 2017). These results suggest that certain parental characteristics may have an additive influence, and therefore considering clusters of parental characteristics rather than individual characteristics may be more clinically meaningful. In particular, the synergy between characteristics within the clusters may further influence CHST.

Similar to recommendations for encouraging healthy diet and other lifestyle behaviours (Dumuid et al., 2017; Poulain, Peschel, et al., 2018), ST should be treated with equal importance. Parents need to be updated with current and evidence-based recommendations for healthy screen use in children. These recommendations should encourage parents to utilise features on screens that can provide parents with immediate feedback of their child's ST use and the content viewed. If parents are more informed about their children's screen use, it is likely that this is reflected in their own screen use. This information also needs be widely accessible and easy to implement given the daily demands

and stress that parents experience. The findings suggest that parents are more likely to implement recommendations if they have positive wellbeing and self-efficacy to do so. Therefore, promotion of positive wellbeing and sense of self may likely see other behaviours follow suit.

Developmental Outcomes

Given only four studies found a relationship between excessive CHST and negative developmental outcomes in children, results should be interpreted with caution (Cerniglia et al., 2021; Cho & Lee, 2017; McDaniel & Radesky, 2018; Poulain, Vogel, et al., 2018a). These negative outcomes included greater internalising and externalising problems, such as increased emotional dysregulation, withdrawal, aggression, hyperactivity, conduct problems, and inattention. From these studies, only two were longitudinal in nature, and thus it is difficult to determine strong conclusions regarding temporal trends particularly as developmental outcomes change across time. In addition, these studies did not differentiate between active vs. passing viewing and educational vs. recreational content. This area of research still represents a significant gap in the field.

Although Gülay Ogelman et al. (2018) identified no association between CHST and social skills, this may be due to other variables that similarly influence the acquisition of these skills, such as parenting practices. Despite evidence of negative implications for children engaging in elevated levels of ST, the somewhat contradictory and limited findings reported above suggest that further research is required to explain these alleged implications of CHST. Little is known regarding the benefits of CHST on child development, and thus future research may benefit from the examination of the conditions under which ST leads to positive outcomes for children.

Most studies focused on the effect of high CHST on child development, however the direction of this relationship warrants further research. It may be that children with

limitations in social, emotional or behavioural skills are more inclined to use screens. For instance, a child with social anxiety may avoid distressing interpersonal engagement by maintaining attention on a screen, thus perpetuating their anxiety (Kley et al., 2012). This deficit in social and emotional skills may be exacerbated later in childhood, leading to additional developmental difficulties. Future prospective studies that track children's developmental outcomes over time are needed to ascertain whether a reciprocal relationship of this nature exists.

Limitations and Future Directions

Despite the recent proliferation of CHST, the majority of the existing ST literature focuses heavily on TST. In an effort to provide an understanding of characteristics associated with CHST and its implications for development, our review did not include data on TST, seeking to isolate findings specific to CHST with a view to addressing this limitation in the literature. With only two longitudinal studies included in our review, cross-sectional data was overrepresented, as it has been in previous reviews, with prospective studies remaining an important priority for ongoing research. In addition, few included studies explored implications of CHST for development, and thus future research should investigate the impact of devices across critical developmental periods, given the rapid changes experienced during early childhood.

A number of methodological weaknesses were noted in the papers included in this review. Most findings were based on self-report data and subjected to recall or social desirability bias. Lack of consistent reporting of participant data, such gender of children or the frequency, type, and proportion of ST, made it difficult to compare findings across studies and determine the extent to which research samples were representative of the general population. Several of the studies sampled from a diverse range of ages, and therefore age-

related differences regarding parental characteristics were difficult to determine. These methodological issues and differences made it difficult to employ a meta-analysis design.

Few studies investigated the role of parental wellbeing and its relation to CHST. Parental wellbeing may be a contributing factor in parents facilitating the use of CHST, due to their limitations to emotionally tune into and engage with their children. It may be that parents who are experiencing mental health difficulties may be less able to connect with their children, attend or model adaptive responses, present as heightened in their levels of arousal or reactivity, and limited in their capacity to spend time with their child. A potential field of protective research specific to this population may follow that focuses on providing parents with strategies to promote healthy ST behaviour.

Conclusions

CHST has quickly become a common early childhood activity. Understanding the factors underpinning its use and impact on child development represents a worthy pursuit to informing healthy ST practices. This review suggests that healthy ST habits need to be established early on in order to facilitate optimal development in children, in which parents are key drivers of such habits. As a myriad of parental characteristics contribute to CHST, these characteristics cannot be viewed in isolation. Although higher levels of CHST was also shown to have greater negative than positive implications for developmental outcomes in children, this may reflect an inherent bias in the literature that has focused on detrimental outcomes rather than potential benefit. It is envisaged that the conclusions from this review will assist future research to conceptualise the influence that CHST may have on children's developmental outcomes, and support the consideration of a complex range of factors when it comes to the development of guidelines for CHST. Ultimately, this review hopes to shed light on the intricate interplay between parental characteristics, CHST and developmental outcomes, as future research continues to explore the implications of CHST.

CHAPTER 4: Directions for Upcoming Studies

Findings from the Systematic Review

ST continues to be a popular pastime for young children, particularly those entering formal schooling at around four to five years of age. Study one which examined the longitudinal effects of traditional ST on children's academic outcomes over the immediate period after handheld devices were introduced, namely from 2008 to 2015. This study provided a historical context to the popularity of screen use among children. The preceding chapter (Study 2) presented a systematic review examining the parental characteristics associated with child handheld ST, and the effects of handheld ST on child developmental outcomes. This review synthesised the current evidence base from handheld ST literature published in the past decade, and provided a rationale for the need to undertake further research on handheld devices.

In Chapter 3, the review identified number of parental characteristics that facilitate and are associated with increased child handheld ST. These included: increased PST (Connell et al., 2015; Lauricella et al., 2015; McDaniel & Radesky, 2018; Myruski et al., 2017; Nikken & Schols, 2015), greater positive attitudes towards ST (Baek et al., 2013; Bentley et al., 2016; Kabali et al., 2015; Kulakci-Altintas, 2019; Lauricella et al., 2015; McCloskey et al., 2018), decreased limit-setting practices and perceived self-efficacy in enforcing limits (Baek et al., 2013; Kesten et al., 2015; Nikken & Schols, 2015; Seo & Lee, 2017; Solomon-Moore et al., 2017), poorer parental wellbeing, (Pempek & McDaniel, 2016), higher levels of parental anxiety (Seo & Lee, 2017), less availability for children (Solomon-Moore et al., 2017), and increased permissive parenting styles (Connell et al., 2015). Overall, the review indicated that parents are important key targets to consider for intervention and prevention purposes aimed at creating a healthy screen environment for children.

These findings provide support for the initial aim of this thesis, which was to examine a range of parental characteristics that impact children's ST. As discussed in the previous chapter, these results should be interpreted with caution given that there were methodological differences between studies. For example, some studies did not report all participant and ST characteristics, such as opt-in rates, gender of children and the frequency, type, duration and proportion of ST. These discrepancies made it difficult to compare results across studies. The majority of findings were also based on self-reported data and were subject to social desirability bias, hence limiting the results.

In addition, the systematic review investigated the developmental outcomes associated with handheld ST in children. Only five studies were extracted, highlighting a significant gap in the literature. Of these studies, four found that greater handheld ST is associated with increased internalising and externalising problems, and with limitations on social skills and emotion regulation (Cerniglia et al., 2021; Cho & Lee, 2017; McDaniel & Radesky, 2018; Poulain, Vogel, et al., 2018b). However, one study did not find a significant association between handheld ST and child social skills (Gülay Ogelman et al., 2018). Due to the limited number of studies extracted, current research has been unable to specify consistent and feasible explanations, and thus it is difficult to draw meaningful conclusions.

Directions for Upcoming Studies

At large, the findings from the systematic review, study two, synthesised the evidence base and concluded that parents shape and influence children's ST habits and behaviours in particularly in relation to handheld devices. However, limitations were noted and there is still room for ongoing research. While this review aimed to collect data from both cross-sectional and longitudinal studies, there was a lack of studies that investigated temporal relations. The

systematic review highlighted the need for more extensive research regarding the effects of ST on developmental outcomes in children.

Emerging evidence from the systematic review also suggested that parental mental health is a contributing factor to children's ST (Seo & Lee, 2017); however, this remains underexplored in the field. Mental health difficulties in parents impact on their capacity to effectively connect with their child and respond sensitively to their needs (Borre & Kliewer, 2014; Pape & Collins, 2011). These parents may have a decreased tolerance for responding appropriately to their child's misbehaviour or emotional distress (Oyserman et al., 2005). Given this, screens may become a medium for managing children's emotions and behaviours for parents with mental health difficulties.

Future research exploring similar relationships with more current and portable forms of screens may also consider a multitude of parental characteristics in order to provide a holistic view of the factors contributing to children's screen use. Moreover, the global COVID-19 pandemic has changed the way screens are utilised. In Australia, many children have shifted to online learning, and have increasingly engaged with screens due to lockdowns. As the world navigates through the pandemic, it will be interesting to see how it affects children's long-term outcomes.

The upcoming chapter will explore the relationship between parental mental health, handheld ST and child developmental outcomes, such as internalising and externalising symptoms. Study three will explore these cross-sectional relationships in order to inform the basis for future longitudinal studies. Towards the end of the thesis, study four will incorporate a longitudinal design and expand on the findings of study three, using the same dataset with two time points. This study will seek to investigate these relationships across the developmental trajectory of children at the start of and during formal schooling.

CHAPTER 5: Handheld Devices: The Barrier for Parents with Mental Health Difficulties in Child Outcomes

Handheld Devices: The Barrier for Parents with Mental Health Difficulties in Child Outcomes

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Abstract

The parenting landscape has changed dramatically over the last decade with the increasing prevalence of screen time. There is a growing body of evidence that handheld devices may disrupt fundamental parent-child interactions, however little is known regarding the effect of these devices for parents with mental health difficulties on child outcomes. The Australian Department of Health (2019) has recommended that children between two and five years old should be limited to less than an hour of screen time per day. A cross-sectional study of 214 parents with children aged 4.5-6 years old was conducted to examine the relationship between parental mental health, handheld screen time and child outcomes. Results from bivariate correlations indicated parental anxiety, depression and stress was significantly associated with parental phone use, such that greater symptoms was associated with increased screen time. Parental anxiety was also associated with parental tablet use, and child phone and tablet use. Further analyses showed that no mediation effects were observed among key variables. Most children were adhering to screen time guidelines, which implied that children showed reduced internalising and externalising problems. These findings have implications for policymakers and allied health professionals to consider the effects of parental mental health within the screen time framework for children's wellbeing.

Keywords: handheld devices, screen time, mental health, child outcomes, parent

Introduction

The nature of parenting has continued to evolve over the last few decades with the increasing prevalence of screen time, which refers to time spent on either handheld technology, such as smartphones, iPads and tablets, or non-handheld technology, such as television (TV), video games or computers (Ponti et al., 2017). Both parents and children are spending more time on handheld screen time thus compromising quality time together and development of secure attachments (Kildare & Middlemiss, 2017; Rideout, 2013). Children require attachment-rich and emotionally meaningful interactions with their parents to facilitate healthy development and wellbeing. Based on attachment theory, a secure attachment refers to an emotional bond between the parent and child that is characterised by high parental sensitivity and responsiveness (Bowlby, 1969; Kildare & Middlemiss, 2017). This emotional bond should lead to a feeling of security or trust that an individual develops in themselves and expectations about others (Keller, 2018). Increased screen time may disrupt important attachment processes, which are fundamental for a child's wellbeing.

The Australian Department of Health (2019) has recommended that children between the ages of two and five should be limited to less than one hour of screen time per day, which involves sitting and watching TV and engaging in other handheld devices. A recent study of Australian children aged 0–12 years old demonstrated that children aged between 1 and 4 had the highest proportion of screen time exceeding current guidelines compared to children aged 5–12 years old (Tooth et al., 2019). The utilisation of handheld devices has grown in popularity and accessibility with reports that 63% of American children aged up to eight years old own a smartphone, and 40% owning a tablet (Rideout, 2013). Rideout (2013) identified that with increased access and ownership of devices had led to greater use among children. Children can engage in a range of activities, such as watching videos, playing games, using educational or other applications, completing homework or listening to music

(Rideout, 2013). Research has also shown that these devices are popular amongst parents, where around 83% of parents with children age six and under engage in handheld devices on a daily basis (Hamel & Rideout, 2006). Parents may use devices to help their children learn, manage their behaviour, enforcing discipline or for their own personal use, such as for social networking or entertainment purposes (Bentley et al., 2016; Yu & Baxter, 2016). Given the increasing popularity of handheld devices, it is imperative that we increase our understanding of the effects of handheld screen time within the parent-child dynamic.

The mental health of parents plays an important role in effective parenting, and has consequences on the interpersonal dynamic between the parent and child (Reupert et al., 2013). Mental health refers to the state of emotional and social wellbeing and affects how individuals cope with ongoing stressors, whether they can reach their potential, and impacts on their ongoing capacity to interact and engage with others (Australian Health Ministers, 2003). Parents with mental health difficulties (MHD) tend to struggle with effective monitoring and connecting with their child, and have a lower tolerance for responding to their child's misbehaviour or emotional distress (Borre & Kliewer, 2014). Parental depression is associated with several parenting behaviours such as reduced positive emotions, warmth, sensitivity, and responsiveness, and greater negative emotions, hostility, intrusiveness, and disengagement (Aktar & Bögels, 2017; Wilson & Durbin, 2010). These parenting behaviours were also similarly associated with increased parenting stress in a study with mother-child dyads (Clowtis et al., 2016). Further evidence suggested that anxious parents tended to be less sensitive towards their children, and were unlikely to provide opportunities of autonomy for their children (Pape & Collins, 2011). Due to these limitations and experience of negative affect, parents with MHD may be less likely to provide an optimal interpersonal environment for their child (Aktar & Bögels, 2017). As a result, these parents have a greater likelihood to form insecure attachments with their child.

There is limited evidence exploring the role of handheld devices on the parent-child dynamic, however it has been suggested that these devices may lead to less engagement from parents with their children (Radesky et al., 2014). Parents with MHD have to compete between the demands of managing their own mental health needs and that of their child's needs (Acri & Hoagwood, 2015; van der Ende et al., 2016). It is possible parents with MHD may utilise devices more than those without MHD to keep their child quiet or divert their attention to create time for work or domestic duties. Several studies have demonstrated that handheld devices may lead to disruptions to parenting, as children may receive even less interpersonal and interactive communication, and less presence of and responsiveness by parents to their needs (Kildare & Middlemiss, 2017; Oduor et al., 2016; Radesky et al., 2014; Radesky, Miller, et al., 2015). For example, Radesky et al. (2014) observed parents who engaged with mobile device use had children who either accepted the lack of interaction and entertained themselves, whilst others continued to increase their bids for attention or received negative parental responses. These parental responses included scolding tones or repeated verbal instructions using robotic tones that were insensitive to child's immediate needs (Radesky et al., 2014). Moreover, children tended to imitate these screen time behaviours from their parents, leading to a reciprocal effect within the child-parent dynamic (Lauricella et al., 2015). The mental health of parents combined with the rise of and increasing use of modern screen-based technologies demonstrates an increasing need to understand how this interaction impacts on child outcomes.

Parental Mental Health, Screen Time and Child Outcomes

There is a strong evidence base demonstrating that increased parental MHD is associated with poorer outcomes for children. For example, children are more vulnerable to develop a mental illness, higher risk of suicide, tend to have a disrupted family environment, decreased ability to adapt to adversity, insecure attachment, low self-worth, and difficulties

with academic competence (McLaughlin et al., 2012; Mensah & Kiernan, 2010; O'Reilly & Maguire, 2018; Reupert et al., 2013). Parental depression has shown to be associated with a higher risk of depression and anxiety, increased disruptive or aggressive behaviours, as well as physical ill health, and poor cognitive development in children (Johnson & Flake, 2007; Kiernan & Huerta, 2008; Sullivan et al., 2021). Longitudinal studies have further demonstrated that children of depressed parents have a threefold increase risk of depression, similar increase in phobias, and a greater risk of the development of substance abuse or panic disorders (Weissman et al., 2016). Although there is a greater likelihood of children of parents with MHD to show poor emotional, social or behavioural development, there is evidence to indicate that some children do not suffer any adverse effects and several parents are still able to parent their children effectively (Smith, 2004).

Similarly, increased handheld screen time is also associated with poorer child outcomes, particularly internalising and externalising problems in children (Hosokawa, 2018; McDaniel & Radesky, 2018). Internalising problems refers to anxiety and depression symptoms, whereas externalising problems are characterised by aggression, defiant behaviours, and attention difficulties (van Lier et al., 2012). Time displacement theory proposes that time spent on screens may take away valuable time from important developmental activities and tasks (Shin, 2004). For example, children may spend less time having rich and meaningful interactions with their parents, playing with toys, reading, creative play, or socialising with peers (Rideout, 2013; Syväoja et al., 2013; Vandewater et al., 2006). Hosokawa (2018) demonstrated that increased handheld screen time was associated with a greater likelihood of externalising problems in preschool children, such as conduct problems, hyperactivity, and attention difficulties. Another study reported similar findings, where a dose-response relationship was observed between screen time and externalising problems in preschool children, in particular, attention difficulties (Tamana et

al., 2019). However, McDaniel and Radesky (2018) also observed this relationship in both internalising and externalising problems in children. These findings have identified that there are several emotional and behavioural concerns when children engage in excessive screen time.

Current evidence proposes significant associations exist between parents with MHD and screen time with poorer child outcomes, but an association between parental MHD and screen time is not as clear. Further examination of this relationship may provide clarity towards the complex interplay between these variables. It is well acknowledged that parents who exhibit MHD, present with challenges in effective parenting, and are more likely to form insecure attachments with their child (Khan & Renk, 2018). Therefore, handheld devices could potentially act as a "barrier" for parents in this population to facilitate positive outcomes for their children. For example, parents with mental health challenges may engage in screen time as a coping mechanism such as using mobile devices as a distraction to alleviate anxiety in certain situations (Cheever et al., 2014). One study suggested that depressed parents may feel more fatigued, and thus engage in more screen time (Tang et al., 2021). Social learning theory suggests that parental behaviours are often modelled to their children and screen use by parents is one such example (Bandura, 1977). In fact, studies have shown that increased parental screen time was associated with greater child screen time (Lauricella et al., 2015; Nikken & Schols, 2015). Handheld devices have been likened to an "electronic babysitter" (Lindsay et al., 2009), and this may appeal to parents with MHD who struggle with competing demands. It is hypothesised that children who do not receive enough attention from their parents may defer to devices or other activities to keep themselves occupied. Further understanding of the effects of handheld devices within parents who present with poorer mental health may assist with providing a climate where children can flourish and thrive.

Aim of Present Study

This research aims to investigate the effects of handheld screen time on the relationship between parental mental health with internalising and externalising problems in children, by addressing the following questions:

1) Is parental mental health significantly associated with parental and child screen time?
2) Does parental and child screen time significantly mediate the relationship between parental mental health and internalising problems in children?
3) Does parental and child screen time significantly mediate the relationship between parental mental health and externalising problems in children?

Method

Participants

A community sample of 214 participants (193 mothers, 18 fathers, 3 other) with a mean age of 36.63 years (*SD* = 4.88 range = 20-59) was recruited through government, catholic and private schools; childcare agencies; children services, social media community groups, and GP family practices. Eligible participants were parents of children aged 4.5 up to 6 years old (134 boys, 80 girls, *M* = 5.23*, SD* = .44). Within this sample, 5.1% of children had been formally diagnosed with either Attention-Deficit/Hyperactive Disorder, Autism Spectrum Disorder, Specific Learning Disorder or a Brain Injury. The majority of parents were Anglo-Australian (67.8%), graduated with university-level education (68.2%), married (79%), employed either full-time or part-time (72.4%), and earned a combined annual household income of more than $100,000 (71.5%). See Table 1 for descriptive statistics for demographic variables.

Table 1: Descriptive Statistics of Demographic Variables

Demographic Variable	**N**	**%**	**M(SD)**
Age (years)			
Parent	214	100	36.63(4.88)
Child	214	100	5.23(.44)
Child Gender			
Male	134	62.6	
Female	80	37.4	
Relationship of participant to child			
Mother	193	90.2	
Father	18	8.4	
Other	3	1.4	
Ethnicity			
Anglo-Australian	145	67.8	
Asian	14	6.5	
British	10	4.7	
Other European	17	7.9	
Indian, Sri Lankan, Pakistani or Bangladeshi	5	2.3	
Aboriginal	5	2.3	
Other	18	8.5	
Education			
< Year 10 Cert	1	.5	
High School Certificate	21	9.8	
Dip/TAFE or equivalent	46	21.5	
Undergraduate degree	77	36	
Post-graduate degree	69	32.2	
Annual household income			
<$100,000	61	28.5	
$100,000-$150,000	64	29.9	
$150,000-$200,000	44	20.6	
>$200,000	45	21	
Employment			
Full-time	78	36.4	
Part-time	77	36	
Casual	16	7.5	
Volunteer	1	.5	
Household duties	30	14	
Student	11	5.1	
Unemployed	1	.5	
Relationship status			
Married	168	79	
Divorced	4	1.9	
Separated	5	2.3	
Widowed	2	.9	
Partnered	27	12.6	
Single	7	3.3	
Formal diagnosis for child			
ADHD	2	.9	
ASD	3	1.4	
SLD	2	.9	
Brain Injury	4	1.9	
None	203	94.9	

Measures

Symptoms of Anxiety

The Beck Anxiety Inventory (BAI; Beck et al., 1988) is a 21-item self-report measure of anxiety. Examples of items include: "Fear of worst happening" and "Dizzy or lightheaded". Responses were rated on a 4-point Likert-scale (0 = *not at all*; 4 = *severely – it bothered me a lot*) over the past month. Higher scores indicated greater severity of anxiety. The present sample demonstrated excellent internal consistency (α = .92).

Symptoms of Depression

The Patient Health Questionnaire (PHQ; Kroenke et al., 2001) is a 9-item self-report screener for the severity of depression. Examples of items include: "Feeling down, depressed or hopeless" and "Poor appetite or overeating". Responses were rated on a 4-point Likert-scale (0 = *not at all*; 4 = *nearly everyday*) over the past two weeks. Higher scores indicated higher levels of depression. In the present sample, this measure showed high internal consistency (α = .88).

Symptoms of Stress

The Perceived Stress Scales (PSS; Cohen et al., 1983) is a 10-item measure that assesses for stress. Examples of items include: "In the last month, how often have you been able to control irritations in your life?" and "In the last month, how often have you felt that things were going your way?". Responses were rated on a 5-point Likert-scale (1 = *never*; 5 = *very often*) over the past month. Higher scores indicated higher levels of perceived stress. Internal consistency was adequate in the current sample (α = .65).

Screen Time

Adapted from the Common Sense Media's Screen Time survey (Rideout, 2013), parents were asked how much time in hours they spend with handheld devices (iPad, tablet,

smartphones and/or similar) on a typical weekday and weekend day. Parents were then asked a similar question to report on their child's screen time. To calculate screen time for parents and children, weekday times were multiplied by five and weekend day times were multiplied by two, and thus summed together. This amount of screen time was divided by seven in order to calculate the average daily screen time spent on each type of handheld device. Other questions pertaining to screen time include: household ownership and child use of all screen media types, child ownership and activities on handheld screen devices, parental reasons for child screen time, and differences in time spent with peers/family with handheld screen devices.

Internalising and Externalising Problems

The Child Behaviour Checklist, 1.5-5 years old, (CBCL; Achenbach & Rescorla, 2000; Achenbach & Rescorla, 2001) is a 99-item parent-completed questionnaire regarding emotional, social, and behavioural difficulties within the last six months. It consists of three main scales: internalising (e.g. "whining", "sulks a lot"), externalising (e.g. "restless", "easily frustrated"), and other problems (e.g. "cruel to animals", "overeating"). In addition, six syndrome subscales can also be calculated (i.e. emotionally reactive, anxious/depressed, somatic complaints, withdrawn, sleep problems, attention problems aggressive problems). A total problems score can be computed by summing the internalising and externalising problems score. Parents responded to items on a 3-point Likert-scale (0 = *not true*; 2 = *very true*). A higher score represented higher severity. The current sample showed strong internal consistency (α = .97).

Procedure

All study procedures were approved by the University of Technology Sydney Human Research Ethics Committee [ETH18-2354]. All participants provided informed consent prior

to beginning the study. Participants completed a battery of questionnaires administered online via Qualtrics, which took approximately 20 minutes to complete.

Analysis Plan

Bivariate correlational analyses was conducted to investigate associations between parental mental health and screen time. PROCESS macro for SPSS recommended by Hayes (2017) was used to test for mediation. Five thousand bootstrap resamples were used to generate 95% confidence intervals that assessed the size and significance of the indirect effect. Hayes (2017) proposed that mediation is a causal explanation, where a mediator variable will carry the effect of an independent variable on a dependent variable. However, data that is collected at a single time point or purely correlational may not be able to make these causal claims. Although there are these limitations, mediation can still be conducted based on the theory of the associated variables. As mentioned earlier, past research has demonstrated that there is a strong association that exists between parental mental health and screen time with poor child outcomes. In addition, correlational analyses illustrated that there is an association between all parental mental health measures and child internalising and externalising symptoms, as well as some of the screen time measures. Moreover, several previous studies have used mediational analyses with cross-sectional data (Fliek et al., 2017; Shanker et al., 2017; Ştefan & Avram, 2017). Six mediation models were undertaken with parental mental health (i.e. anxiety, depression and stress scores) as the independent variable, child internalising and externalising problems (i.e. CBCL scores) as the dependent variable, and parental and child screen time (i.e. parental and child tablet and phone use) as potential mediator variables. Covariates for analyses included: parent age, annual household income and highest education level of parent.

Results

See Table 2 for the descriptive statistics of the key study variables and Table 3 for the bivariate correlations among the study variables and covariates.

Table 2: Descriptive Statistics of Key Study Variables

Study Variable	**N**	**%**
Parental anxiety		
Low	64	29.9
Moderate	132	61.7
Concerning	18	18
Parental depression		
Minimal or none	0	0
Mild	37	17.3
Moderate	135	63.1
Moderately severe	32	15
Severe	10	4.7
Parental stress		
Low	0	0
Moderate	111	52.11
High	102	47.88
Child usage		
Tablet/iPad	184	86
Smartphone	174	81.3
iPod touch	11	5.1
Kindle eBook reader	2	.9
TV	180	84.1
Gaming console	58	27.1
PC/Laptop	81	37.9
None	2	.9
Child handheld device ownership		
Tablet/iPad	59	27.6
Smartphone	5	2.3
iPod touch	3	1.4
Kindle eBook reader	1	.5
Gaming console	6	2.8
None	146	68.2
Device activity		
Touch/scroll to look at things	169	79
Watch videos	181	84.6
Watch TV shows	168	78.5
Play games	163	76.2
Listen to music	122	57
Educational/learning apps	172	80.4
Other apps	57	26.6
Communicate to family/friends	138	64.5
None	1	.5
Other	13	6.1
Reasons for ST		
Run errands outside the house	33	15.4
Do chores around the house	96	44.9
Keep child calm in public gatherings	69	32.2
Put child to sleep	10	4.7
Keep child occupied whilst in meeting, class or other activity	70	32.7

Study Variable	N	%
Reward child for good behaviour	77	36
Other	102	47.7
Devices cause family to spend		
More time with family	12	5.6
Less time with family	50	23.4
Does not make a difference	152	71
Devices cause child to spend		
More time with peers	2	.9
Less time with peers	28	13.1
Does not make a difference	183	85.5
Child internalising problems		
Normal	198	92.5
Borderline	7	3.3
Clinical	9	4.2
Child externalising problems		
Normal	200	93.5
Borderline	7	3.3
Clinical	7	3.3

Key. For symptoms of anxiety, a score of 0-21 = low anxiety, 22-35 = moderate anxiety, and ≥36 = potentially concerning levels of anxiety. For symptoms of depression, a score of 0-4 = minimal or none, 5-9 = mild, 10-14 = moderate, 15-19 = moderately severe, and 20-27 = severe. For symptoms of stress, a score of 0-13 = low stress, 14-26 = moderate stress, and 27-40 = high perceived stress. For internalising problems, a score of 0-13 = normal, 14-17 = borderline, and >18 = clinical. For externalising problems, a score of 0-20 = normal, 21-24 = borderline, and >25 = clinical.

Bivariate Correlational Analyses

A bivariate correlational analysis was conducted to examine the relations between key study variables. All parental mental health measures showed strong significant associations with parental phone use, such that greater symptoms was associated with increased screen time (anxiety: $r_s = 0.304\ p < 0.001$; depression: $r_s = 0.249,\ p < 0.001$; stress: $r_s = 0.25,\ p < 0.001$). Parental anxiety was significantly associated with and parent tablet use ($r_S = 0.145,\ p = 0.034$). In addition, parental anxiety was significantly associated with child phone and tablet use ($r_s = 0.152,\ p = 0.026;\ r_s = 0.152,\ p = 0.026,\ respectively$). Parental and child phone use was significantly associated with internalising problems in children ($r_s = 0.176,\ p = 0.01;\ r_s = 0.157,\ p = 0.021,\ respectively$). Child phone use was significantly associated with externalising problems in children ($r_S = 0.17,\ p = 0.013$).

Moreover, all parental mental health measures were significantly associated with both internalising and externalising problems in children. Specifically, parental anxiety was

Table 3: Bivariate Correlations among Key Study Variables and Covariates (N = 214)

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Parental Anxiety	1											
2. Parental Depression	.727**	1										
3. Parental Stress	.557**	.567**	1									
4. Parental Phone Use	.304**	.249**	.25**	1								
5. Parental Tablet Use	.145*	.045	.113	.286**	1							
6. Child Phone Use	.152*	.061	.171*	.240**	.428**	1						
7. Child Tablet Use	.152*	.131	.074	.259**	.292**	.451**	1					
8. Child Internalising Problems	.145*	.173*	.135*	.176**	.067	.157*	-.003	1				
9. Child Externalising Problems	.174*	.189**	.269**	.132	.045	.17*	.024	.741**	1			
10. Parent Age	-.135*	-.175*	-.077	-.191**	-.181**	-.25**	-.054	-.146*	-.095	1		
11. Annual Household Income	-.158*	-.128	-.162*	-.055	-.168*	-.167*	.03	-.091	-.101	.229**	1	
12. Highest Education Level	-.068	-.041	-.011	-.164*	-.177**	-.103	.031	-.054	0	.267**	.268**	1

Note. Correlations between ordinal variables, and ordinal variables with continuous variables are Spearman rank correlation. The remaining correlations were Pearsons.

*p < 0.05 ** p < 0.01

significantly associated with internalising (*r = 0.145, p = 0.034*) and externalising problems (*r = 0.173, p = 0.011*). Parental depression was also significantly related to internalising (*r = 0.173, p = 0.011*) and externalising problems (*r = 0.189, p = 0.006*). Lastly, parental stress showed a weaker association with internalising problems (*r = 0.135, p = 0.048*) compared to externalising problems which had a stronger association (*r = 0.269, p < 0.001*).

Mediation Analyses

Table 4 displays the unstandardised path coefficients in the six models that were conducted. Figures 1 to 6 represent the paths in the mediation models tested. Covariates were parental age, annual household income and educational level, and were not reported in the figures. Supplementary Table 2 includes a table of the unstandardized path coefficients in the six models tested along with covariates.

Table 4: Path coefficients for associations between parental mental health measures, screen time (hours/day), and internalising and externalising problems in children.

Variable	b(SE)	*p* value
Parent Phone Daily Usage ON		
Anxiety	.03(.01)	.00**
Parent Tablet Daily Usage ON		
Anxiety	.01(.01)	.02*
Child Phone Daily Usage ON		
Anxiety	.00(.00)	.39
Child Tablet Daily Usage ON		
Anxiety	.02(.01)	.00**
Externalising Problems ON		
Anxiety	.16(.07)	.04*
Parent Phone Daily Usage	.48(.55)	.39
Parent Tablet Daily Usage	-.76(.88)	.39
Child Phone Daily Usage	1.86(1.22)	.13
Child Tablet Daily Usage	-.66(.89)	.46
Internalising Problems ON		
Anxiety	.11(.07)	.13
Parent Phone Daily Usage	-.02(.54)	.97
Parent Tablet Daily Usage	-.60(.85)	.48
Child Phone Daily Usage	1.38(1.19)	.25
Child Tablet Daily Usage	.06(.87)	.95
Parent Phone Daily Usage ON		
Depression	.04(.02)	.01*
Parent Tablet Daily Usage ON		
Depression	.01(.01)	.31
Child Phone Daily Usage ON		
Depression	-.00(.01)	.81

Variable	b(SE)	*p* value
Child Tablet Daily Usage ON		
Depression	.02(.01)	.08
Externalising Problems ON		
Depression	.32(.13)	.02*
Parent Phone Daily Usage	.48(.55)	.39
Parent Tablet Daily Usage	-.66(.87)	.45
Child Phone Daily Usage	1.96(1.22)	.11
Child Tablet Daily Usage	-.62(.88)	.48
Internalising Problems ON		
Depression	.26(.13)	.04*
Parent Phone Daily Usage	-.04(.54)	.95
Parent Tablet Daily Usage	-.54(.84)	.52
Child Phone Daily Usage	1.48(1.19)	.21
Child Tablet Daily Usage	.06(.86)	.94
Parent Phone Daily Usage ON		
Stress	.05(.02)	.00**
Parent Tablet Daily Usage ON		
Stress	.03(.01)	.03
Child Phone Daily Usage ON		
Stress	.01(.01)	.14
Child Tablet Daily Usage ON		
Stress	.02(.01)	.18
Externalising Problems ON		
Stress	.47(.13)	.00**
Parent Phone Daily Usage	.35(.54)	.52
Parent Tablet Daily Usage	-.86(.86)	.32
Child Phone Daily Usage	1.54(1.19)	.20
Child Tablet Daily Usage	-.39(.86)	.65
Internalising Problems ON		
Stress	.20(.13)	.12
Parent Phone Daily Usage	-.02(.54)	.97
Parent Tablet Daily Usage	-.59(.85)	.49
Child Phone Daily Usage	1.19(1.18)	.32
Child Tablet Daily Usage	.25(.86)	.77

*p < 0.05 ** p < 0.01

Note. Covariates are not shown in the table.

The first model investigated whether parental and child screen time mediated the relationship between parental anxiety and child internalising problems. The results showed that parental anxiety was significantly associated with parental phone use (*b = 0.03, SE = 0.01, p = 0.001*) and tablet use (*b = 0.01, SE = 0.01, p = .019*), as well as child tablet use (*b = 0.02, SE = 0.01, p = 0.004*). The model significantly accounted for 36.9% (p < *.001*) and 36.6% (*p < 0.001*) of the variance in parental phone and tablet use, respectively, as well as 26.1% (*p = 0.005*) and 21.4% (*p = 0.045*) of the variance in child phone and tablet use, respectively.

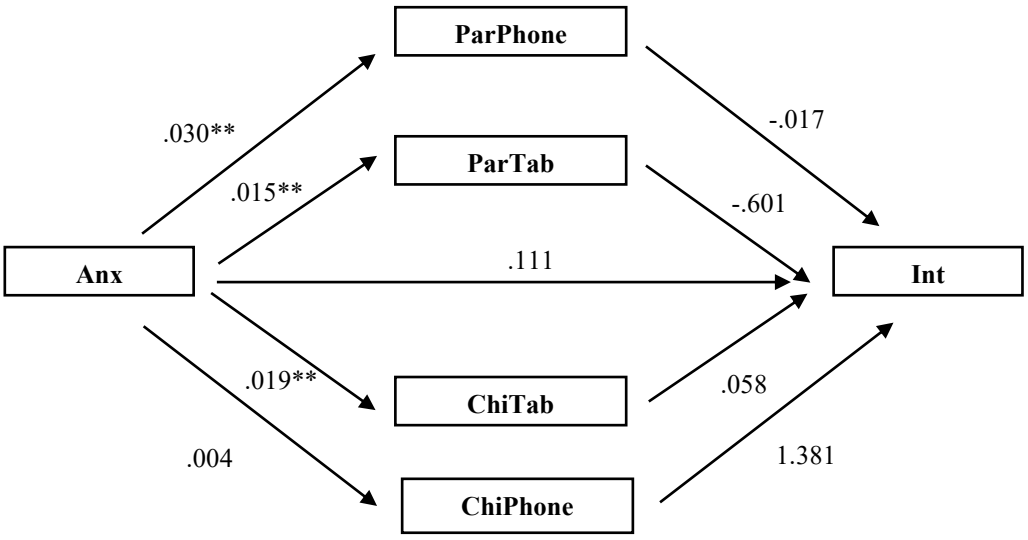

Figure 1. Results for the model testing the mediating effects of parental and child phone and tablet use on the relationship between parental anxiety and internalising problems in children.

The second model examined whether parental and child screen time mediated the relationship between parental depression and child internalising problems. Parental depression was significantly associated with parental phone use (*b = 0.04, SE = 0.02, p = 0.015*), and to child internalising problems (*b = 0.32, SE = 0.13, p = 0.043*). The model significantly accounted for 25.6% (*p = 0.007*) and 34% (*p < 0.001*) of the variance in parental phone and tablet use, respectively. The model also significantly accounted for 26.1% (*p = 0.005*) of the variance in child tablet use.

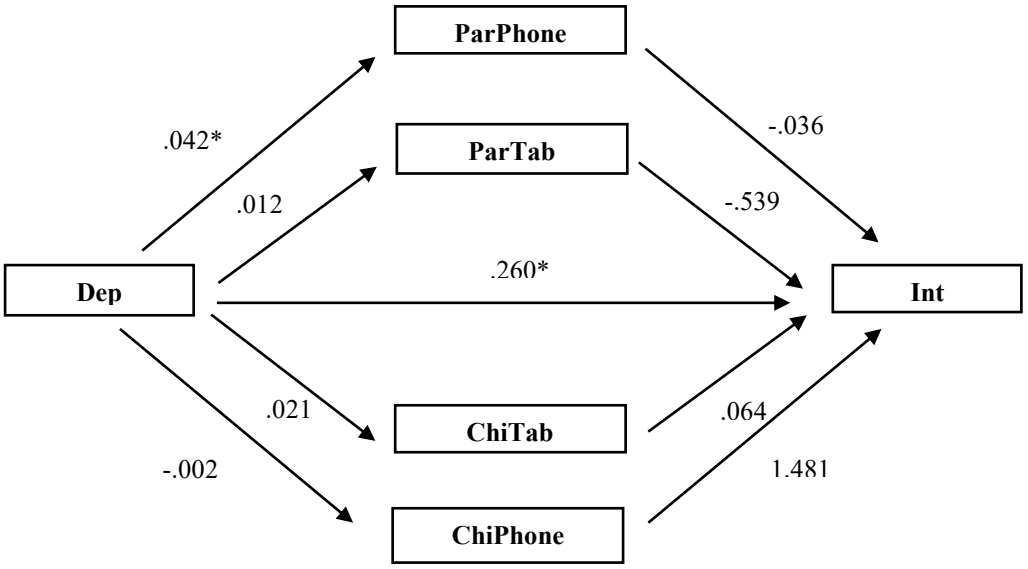

Figure 2. Results for the model testing the mediating effects of parental and child phone and tablet use on the relationship between parental depression and internalising problems in children.

The third model investigated whether parental and child screen time mediated the relationship between parental stress and child internalising problems. Parental stress was significantly related to parental phone use (*b = 0.05, SE = 0.02, p = 0.004*) and tablet use (*b = 0.03, SE = 0.01, p = 0.027*). The model significantly accounted for 35.9% (*p < 0.001*) and 36.3% (*p < 0.001*) of the variance in parental phone and tablet use, respectively, as well as 27.4% (p = *0.003*) of the variance in child phone use.

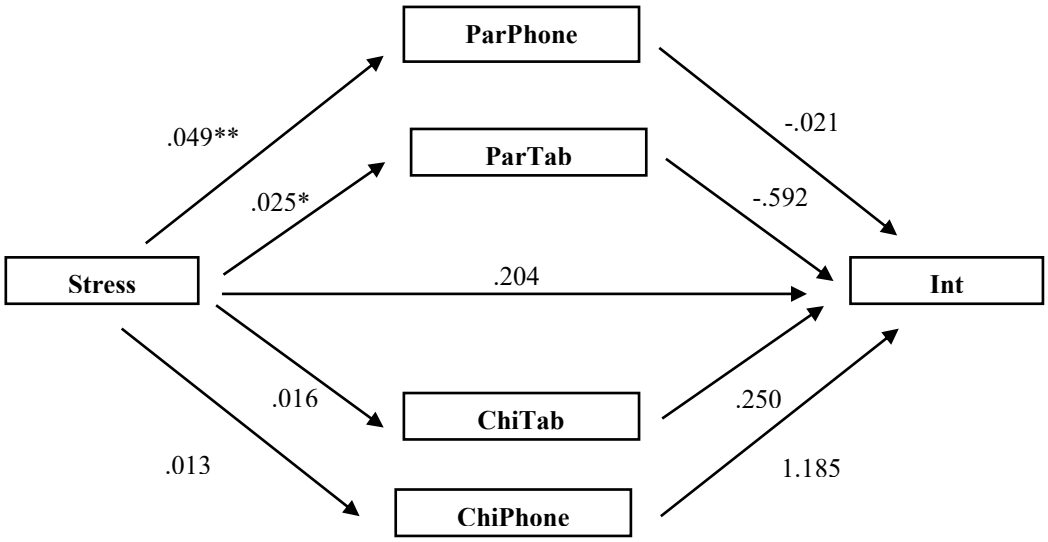

Figure 3. Results for the model testing the mediating effects of parental and child phone and tablet use on the relationship between parental stress and internalising problems in children.

The fourth model assessed whether parental and child screen time mediated the relationship between parental anxiety and child externalising problems. Parental anxiety was significantly associated with parental phone use (*b = 0.03, SE = 0.01, p = 0.001*) and tablet use (*b = 0.01, SE = 0.01, p = 0.019*), child tablet use (*b = 0.02, SE = 0.01, p = 0.004*) and child externalising problems (*b = 0.16, SE = 0.007, p = 0.036*). The model significantly accounted for 36.9% (*p < 0.001*) and 36.6% (*p < 0.001*) of the variance in parental phone and tablet use, respectively. The model also significantly accounted for 26.1% (*p = 0.005*) and 21.4% (*p = 0.045*) of the variance in child phone and tablet use, respectively

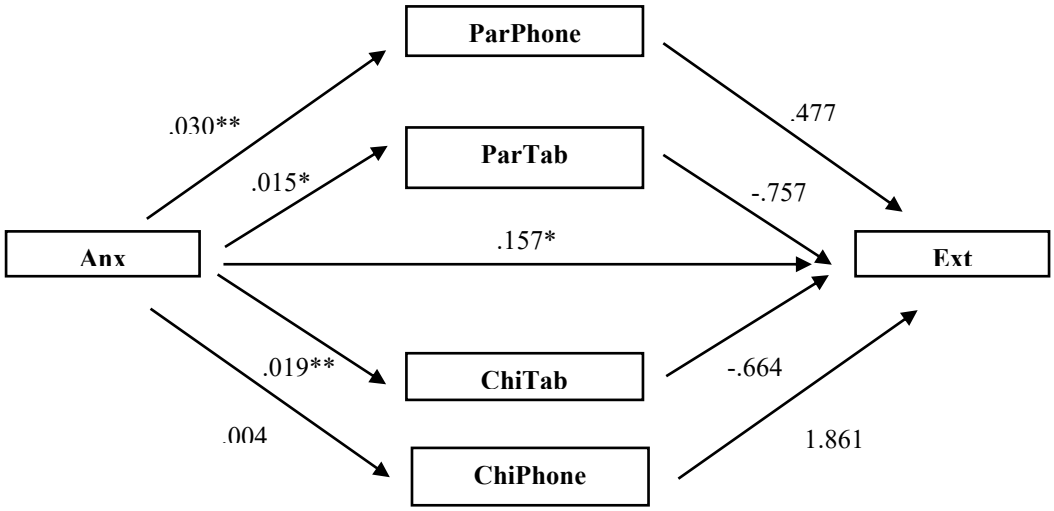

Figure 4. Results for the model testing the mediating effects of parental and child phone and tablet use on the relationship between parental anxiety and externalising problems in children.

The fifth model examined whether parental and child screen time mediated the relationship between parental depression and child externalising problems. Parental depression was significantly related to parental phone use (*b = 0.04, SE = 0.02, p = 0.015*) and child externalising problems (*b = 0.32, SE = 0.13, p = 0.015*). The model significantly accounted for 25.6% (*p = 0.007*) and 34% (*p < 0.001*) of the variance in parental phone and tablet use, respectively, and 26.1% (*p = 0.005*) of the variance in child tablet use.

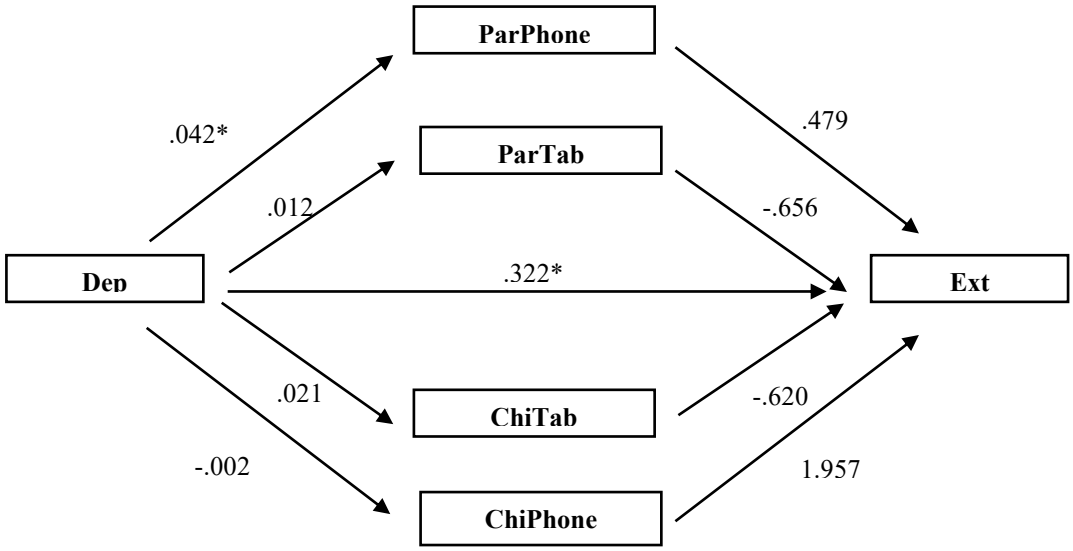

Figure 5. Results for the model testing the mediating effects of parental and child phone and tablet use on the relationship between parental depression and externalising problems in children.

The final model investigated whether parental and child screen time mediated the relationship between parental stress and child externalising problems. Parental stress was significantly associated with parental phone use use (*b = 0.05, SE = 0.02, p = 0.004*) and tablet use (*b = 0.03, SE = 0.01, p = 0.027*), and externalising problems (*b = 0.47, SE = 0.13, p < 0.001*). The model significantly accounted for 35.9% (*p < 0.001*) and 36.3% (*p < 0.001*) of the variance in parental phone and tablet use, respectively, and 27.4% (*p = 0.003*) of the variance in child phone use. In addition, the model significantly accounted for 30.3% (*p = 0.011*) of the variance in externalising problems.

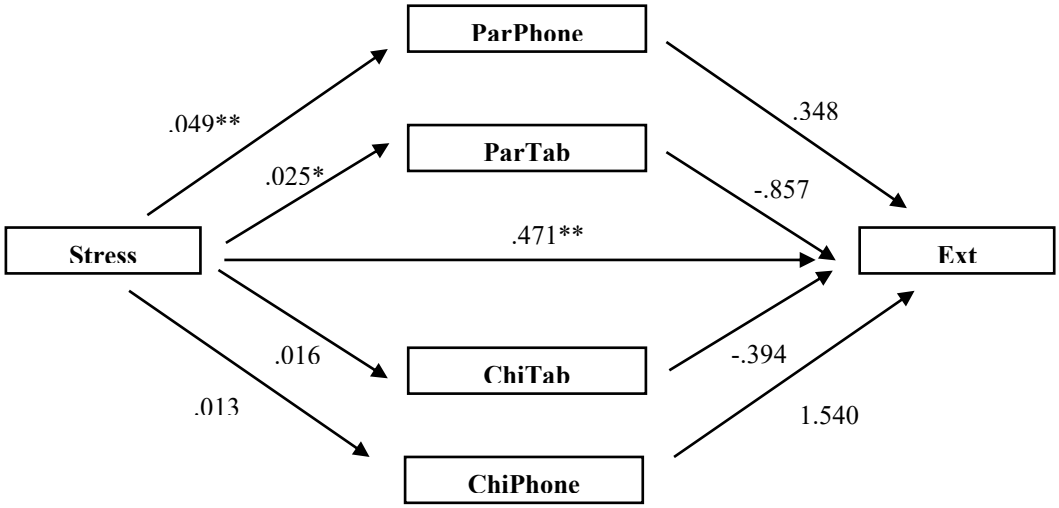

Figure 6. Results for the model testing the mediating effects of parental and child phone and tablet use on the relationship between parental stress and externalising problems in children.

Although significant direct associations were present between parental mental health and parent and child screen time, and parental mental health and internalising and externalising problems, no significant associations were present between parent and child screen time and internalising and externalising problems. In addition, there were no significant mediation effects identified in the six models.

Discussion

This study aimed to investigate the relationship between parental mental health, handheld screen time and child outcomes. In particular, this study sought to answer whether: 1) parental mental health was significantly associated with increased parental and child screen time, 2) parental and child screen time mediated the relationship between parental mental health and internalising problems in children, and 3) parental and child screen time mediated the relationship between parental mental health and externalising problems in children. This study showed support for the first research question, however did not show evidence for the second and third research question.

To the best of the author's knowledge, there has been limited research exploring the effects of parental mental health on screen time. This study identified that parents with increased anxiety showed greater phone and tablet usage. Parents who reported higher symptoms of depression and stress were also more likely to show greater phone usage. In addition, greater parental anxiety was associated with increased child phone and tablet use. A strength of this study was that it considered screen time within separate categories of devices, specifically, smartphones or mobile phones and iPads or tablets. Taken together, these results showed a common trend that greater parental anxiety was associated with higher levels of screen time in both parents and children.

Children are particularly vulnerable when parenting is not consistent, responsive and sensitive to their needs, where this is particularly difficult for parents with MHD. Research has highlighted the importance of parents as a secure base for support, care and affection in order to facilitate positive outcomes for children (Kildare & Middlemiss, 2017). Previous research has identified that handheld devices may disrupt effective parenting (Kildare & Middlemiss, 2017; Oduor et al., 2016; Radesky et al., 2014; Radesky, Miller, et al., 2015),

and these concerns may be exacerbated for parents with MHD. One potential explanation is that parents with these difficulties may engage in increased screen time as a way to cope and unwind from the day. These parents may also be more likely to give their child a screen to keep them calm or occupied given their lower tolerance for their child's misbehaviour or distress. This supports the perceived idea of handheld devices as an effective "electronic babysitter". Moreover, anxious parents may utilise screens as a distraction technique or coping strategy for themselves (Cheever et al., 2014), whilst they may give their child a screen in order to cope with meeting the demands and pressures of parenting and their mental health needs. Given that parents with MHD may struggle with effective parenting and establishing secure attachments, handheld devices may further disrupt these processes. For anxious parents, they more engage in more screen time and therefore become less responsive and sensitive to their child's needs. In response, children may model their parents' behaviour and engage in their own screen time. As a result, children and parents are spending less quality and meaningful time together, all of which to fundamental for a child's healthy development and establishment of a secure attachment.

Although this study showed no evidence of mediation effects of screen time on parental mental health and child outcomes, some interesting results were found. After controlling for parental age, annual household income and education level of the parent, there were several direct associations found between parental mental health with parent and child screen time, as well as with internalising and externalising problems in children. Most parents reported adherence to screen time guidelines for their children, and a large majority of the sample fell within the normal range for internalising and externalising problems in children. This finding demonstrated that meeting screen time guidelines suggested by the Australian Department of Health (2019) may potentially imply a reduction in internalising and externalising problems in children. Moreover, children within this age group often have less

access to and ownership of devices compared to older children, and as a result, will engage in less screen time. Specifically in this sample, there was less than two thirds of children who reportedly owned a tablet/iPad and only 2.3% owned a smartphone. In addition, given that this study was of a cross-sectional nature, it may be difficult to determine causality between variables. One explanation is that increased screen time may not have an immediate effect on child outcomes, and thus further consideration for longitudinal research may be useful to address these findings across the trajectory.

There are a number of limitations in the present study. The direction of links between variables may not occur in the direction proposed or bidirectional relationships may exist. For example, parental screen time may predict increased symptoms of depression, anxiety or stress, because it may take away time spent with family, friends and other healthy lifestyle behaviours, such as physical activity. This study was limited to self-report of parents and subjected to recall or social desirability bias. Parents may underreport screen time habits and maladaptive child outcomes in order to appear socially acceptable. The study did not assess for co-viewing of screens between parent and child, and thus this may have affected how parents measured screen time usage for their child. Additionally, parents may not have accurately reported frequencies of their symptoms of depression, anxiety or stress. Previous studies on alcohol consumption have identified difficulties with truthfulness of self-report data, as individuals may fear negative consequences due to their responses (Devaux & Sassi, 2016; Simons et al., 2015). However, parents were reassured responses were anonymous and non-identifiable. Lastly, the majority of the participants were Anglo-Australian, mothers, attained at least a university-level education and earned more than $100,000 annual household income. Thus, this sample may not be generalisable to ethnic samples of low socioeconomic status (SES) backgrounds. Nevertheless, results should be viewed with caution in light of these limitations.

This study provided a unique outlook to the context of screen time for child outcomes. In particular, this study identified that increased parental mental health was associated with greater screen time, particularly parental anxiety with both parent and child screen time. The current literature reflects a negative bias towards screen time, in which several studies have reported negative consequences for children with ST use (Hosokawa, 2018; McDaniel & Radesky, 2018; Tamana et al., 2019). Although the current study did not demonstrate mediation effects, the findings have shed positive light, such that majority of parents reported adherence to screen time guidelines. This implied that children showed a reduction in internalising and externalising problems. In particular, these findings were present in a sample of parents of high SES backgrounds and suggests that preventative health messages may not be accessible to those of low SES backgrounds. Future directions for research should examine factors that may increase adherence to guidelines and provide explanations as to why parents may do so. Moreover, these studies could explore other potential predictors that may further explain the complex interplay between the variables of interest. Future research should also investigate the effects of parental mental health and screen time across the trajectory to see whether these factors may affect child outcomes during critical developmental periods, in which changes in children have significant influence. In a technologically saturated world, it is important we remain informed and increase our understanding of the effects of screen time in order to provide parents with the tools to build a healthy screen environment for their families and increase positive outcomes for their children.

Prelude to Chapter Six

The upcoming chapter presents a longitudinal study that investigates the relationships between parental mental health, parental and child ST and child outcomes, including internalising and externalising problems. To the best of the author's knowledge, this was one

of the first studies to investigate specific mental health variables, namely symptoms of depression, anxiety and stress in the context of ST.

CHAPTER 6: A Longitudinal Study of the Effects of Parental Mental Health and Handheld Devices on Child Outcomes

A Longitudinal Study on the Effects of Parental Mental Health and Handheld Devices on Child Outcomes

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Abstract

Parental factors and early life experiences are major influences on children's outcomes. This longitudinal study investigated the relationships between the mental health of parents, parental and child screen time (ST), and child outcomes at two time points (T1, April 2019-February 2020; T2, September 2020-February 2021). Participants included mothers and fathers (*N*=214), however due to loss to follow-up the final sample consisted of 101 participants (97 mothers, 4 fathers) with a mean age of 37.55 (*SD* = 4.14). Children of participants had a mean age of T1=5.25 (*SD* = .44) and T2=6.51 (*SD* = .52). Parental anxiety significantly predicted child internalising symptoms, whereas both parental anxiety and depression significantly predicted child externalising symptoms, across time. These findings suggest that after controlling for ST, parental mental health is predictive of temporal child outcomes. Early intervention programs that target parents with mental health concerns and children who engage in excessive ST are warranted.

Keywords: parental mental health; screen time; handheld devices; internalising problems; externalising problems

Introduction

A tsunami of handheld devices has impacted on the current generation of young children whose world is far removed from the sand pits and the butterflies of the pre-digital age and children are now key players in this cultural and digital era. A nationally representative household survey of Australian children conducted by The Royal Children's Hospital Melbourne (2017) found that around two-thirds of primary-school aged children and over a third of preschoolers own a handheld device. Approximately 17% of primary-school aged children and 13% of children under the age of six reportedly use a smartphone daily. For daily tablet use, this equated to 31% of primary-school aged children and 17% of children under the age of six (The Royal Children's Hospital Melbourne, 2017). Kabali et al. (2015) found that majority of children begun using mobile devices within their first year of life, and this was allowed by parents who gave their children a device to use or own. With this rise of the 'portable age', further exploration regarding the implications of the use of handheld devices among young children warrants attention.

The young child brain is developing and early experiences are fundamental to moulding and shaping a healthy growing brain and subsequent wellbeing (Huang et al., 2018; Murgatroyd & Spengler, 2011). Children's exposure to screens may become habitual and early exposure increases the likelihood of increased use in later childhood (Hamilton et al., 2016). ST habits tend to also increase over time to include entertainment rather than educational viewing (Linebarger et al., 2014). The learning of young children is highly malleable, particularly from parental influence. They require considerable support from their parents to develop skills and behaviours that form the basis for good health habits, meaningful relationships and friendships, and adjustment to school, family and community life (Huang et al., 2018). A study by Lee et al. (2018) identified that several parental cognitions and behaviours, as well as the home environment, was associated with toddler ST.

These included: negative outcome expectations for limiting ST, parental self-efficacy to limit ST, parental limit-setting practices, parental modelling of ST, and presence of devices in the bedroom (Lee et al., 2018). These findings suggest that parents who spend more time in front of a screen may facilitate a home environment that is conducive to screen use among children. It is imperative that parents model healthy screen habits and behaviours to their children, as they are among one of the greatest, if not the most, influences in the early years for children

Parental Factors and Screen Time

Young children are curious learners of the world, where they may absorb the surrounding media environment through imitating modelled ST behaviour from their parents (Bandura & Walters, 1977). Several studies have shown that children are more likely to engage in ST when parents are also engaging in similar behaviours (Jago et al., 2012; Lauricella et al., 2015; Rideout & Hamel, 2006). As there is an increasing access to multiple devices in the home, it is now even easier for children to access a device, such as a tablet, whilst their parent is on their smartphone (Lauricella et al., 2015). The effects of COVID-19 have also led to increased screen use among children (Guan et al., 2020; Xiang et al., 2020), where children are staying indoors more often, keeping connected to family/friends or for online learning. In addition, public health orders to stay at home due to the pandemic have also led to increased screen use among adults and children, time spent on electronic media was considered to displace quality interactions between parent and child. These interactions include quality time spent together playing with toys, reading, learning activities, and reduced opportunities for verbal parent-child interaction (Plowman, McPake, et al., 2010; Tomopoulos et al., 2007). Therefore, parents spending more time on screens may reduce such meaningful interactions with their child, and vice versa. As a consequence, decreased parent-child interactions has been shown to be associated with negative developmental outcomes,

such as poor self-regulation and academic achievement (Landry et al., 2002; NICHD Early Child Care Research Network, 2005).

The naïve nature of young children lead them to be developmentally dependent on their caregivers. Early attachment theorists proposed that children require consistent attention and available caregiving in order meet their developmental needs (Bowlby, 1969; Winnicott, 1986). Outcomes for children are sensitive to parental attentiveness, responsivity, modelled behaviour and family/cultural environment (Shonkoff & Phillips, 2000). A meta-analysis of 193 studies identified that maternal depression is a risk factor for adverse child outcomes, such as associations with child internalising and externalising problems (Goodman et al., 2011). Other longitudinal studies have also observed these effects, in both a younger cohort of 2-3 years olds (Bouvette-Turcot et al., 2017), and an older cohort of 10-15 year olds (Elgar et al., 2007). Moreover, a longitudinal family intervention study, the *Strengthening Families Program*, concluded that when parental mental health is considered, a reduction of child emotional and behavioural difficulties was observed in Australian children aged 8-12 years old (Burn et al., 2019).

Parents form the building blocks to encourage children's ST behaviours. These include factors such as parental ST (Jago et al., 2012), attitudes towards ST (Lauricella et al., 2015), limit-setting (Jago et al., 2016), self-efficacy (Campbell, 2010), however parental mental health as a predictor of ST has not been extensively investigated or findings have been ambiguous. One study examining children aged two to five found a positive association between maternal depression and television (TV) use, however did not find this relationship with smartphones or tablet use (Park et al., 2018). A systematic review of 29 studies of correlates of ST in children under three years old revealed that five studies found maternal depression was positively associated with TV, computer and gaming console use, however the mechanisms behind this were unclear (Duch et al., 2013). ST has been a common source

of conflict and tension in the family home (The Royal Children's Hospital Melbourne, 2017), where parents with mental health concerns may have increased difficulty to self-regulate as well as manage their child's ST habits and behaviours, particularly due to their limits in emotion regulation. Parents with greater symptoms of parental mental health may have increased difficulty with meeting the needs of their child, and therefore this may have consequences for their subsequent outcomes (Eckshtain et al., 2018; Reising et al., 2013). Parental mental health considered in the context of ST is an area of research that requires more attention and may be a worthwhile target for early intervention.

Screen Time and Child Outcomes

The portable nature of handheld devices may have a greater impact on children's outcomes given their accessibility, interactiveness and solitary use. Previous research has identified that ST has several implications for child outcomes, particularly the development of internalising and externalising symptoms, although the majority of the research has focused on adolescent samples (Costigan et al., 2013; Perrino et al., 2019) and findings have been conflicting. Internalising problems refers to symptoms of anxiety and depression, whilst externalising problems are characterised by aggression, defiant behaviours, and attention difficulties (van Lier et al., 2012). A systematic review of school-aged children and adolescents identified that there was a positive association between ST and hyperactivity/inattention problems, as well as internalising problems (Suchert et al., 2015). However, findings regarding symptoms of depression were inconsistent, as some studies identified an association with ST whilst others did not. A recent global study of 11-15 year old young people revealed that higher levels of recreational ST was associated with poorer mental health, and this data was collected before the COVID-19 pandemic (Khan et al., 2021). Interestingly, a meta-analysis reported greater levels of ST was associated with increased symptoms of depression in children and adolescents, however this association was

non-linear (Liu et al., 2016). Previous research with similar findings observed adolescents engaging in excessive ST had greater risk of symptoms of depression compared to groups with occasional or regular ST (Kim, 2012; Liang et al., 2009). These results indicated that an appropriate level of ST may not lead to the development of such symptoms. These findings were predominantly reported in adolescent samples, and hence it is unclear whether these results are applicable to younger children, especially given the hours of use among this cohort. This could provide important implications for early prevention of later internalising and externalising problems in adolescence.

Studies have reported a dose-response relationship exists between ST and externalising problems in preschool children, such as conduct problems, hyperactivity, and inattention (Hosokawa, 2018; Tamana et al., 2019). Although, this relationship was not found with internalising child behaviour, such as emotional symptoms and peer problems (Hosokawa, 2018). Potential exposure to violent or aggressive content in ST may encourage such externalising problems (Hosokawa, 2018). Moreover, ST may impact children's capacity to maintain attention due to numerous mechanisms, such as sleep disturbance. Screen use during bedtime is associated with greater arousal and interrupted melatonin production due to the brightness of screens (Kubota et al., 2002). Interestingly, Tansriratanawong et al. (2017) did not observe a significant relationship between ST and externalising problems in children, however a dose-response was found. Tansriratanawong et al. (2017) explained that this may be due to the cross-sectional nature of the study, where ST may not have an immediate effect on child behaviour. Longitudinal studies are potentially more appropriate to gauge temporal relations between these variables and relationships between the mental health of parents, and parent and child ST use.

Aim of Present Research

The present study aimed to investigate the relationships between parental mental health, parental and child ST and child outcomes, which include internalising and externalising problems. To the best of the author's knowledge, this is the first study to examine specific parental mental health factors, which include symptoms of depression, anxiety and stress, and ST as predictors of child outcomes. In addition, this study observed these relationships longitudinally.

It is hypothesised that:

1) Increased symptoms of parental mental health significantly predicts child internalising and externalising symptoms across time.
2) Greater child and parental ST significantly predicts child internalising and externalising symptoms across time.

Method

Participants

A community sample of 214 participants was recruited through government, Catholic and private schools; childcare agencies; children services, social media community groups, and GP family practices. Eligible participants were parents of children aged 4.5 up to 6 years old at the initial time point (T1) (134 boys, 80 girls, $M = 5.23$, $SD = .44$). Follow-up data (T2), in which parents were contacted via email on multiple occasions, was collected approximately 18 months later between September 2020 to February 2021. T1 data was collected pre-COVID-19, whereas T2 data was collected during COVID-19 restrictions. Approximately 51% responded (ie. 109) and completed the follow-up survey. However, data from eight participants were removed due to inappropriate completion of the survey, such as participant codes did not match up and reporting on the incorrect child.

The final sample consisted of 101 participants (97 mothers, 4 fathers) with a mean age of 37.55 (*SD* = 4.14, range = 29-50). Children of participants had a mean age of T1=5.25 (*SD* = .44) and T2=6.51 (*SD* = .52). Most children were males (65.3%). Ethnicity was wide ranging with majority of parents identifying as Anglo-Australian (74.3%), followed by Other European (5.9%), British (5%), Asian (5%), Aboriginal (3%); Indian, Sri Lankan, Pakistani & Bangladeshi (2%), Other ethnicity (2%), North American (1%), Middle-Eastern (1%), or American (1%). Marital status of parents included married (81.2%), partnered (10.9%), separated (4), divorced (2%), widowed (1%) and single (1%). The highest level of education completed by the majority of parents was a university-level of education (72.3%), followed by Diploma/TAFE or equivalent (18.8%) and Year 12 completion with certificate (8.9%). Most participants were employed part-time (41.6%) or full-time (26.7%), completed household duties (15.8%), employed casually (9.9%), and were a student (4%) or unemployed (1%). In addition, the annual household income for parents was similar across the thresholds with those earning less than $100,000 (26.7%); $100,000-150,000 (27.7%); $150,000-200,000 (22.8%) and more than $200,000 (22.8%).

Measures

Demographic Variables

Parents reported on child age and gender, parental age, parental ethnicity, relationship status, annual household income, employment status and highest education level achieved of parent. In addition, parents reported child's age and gender.

Symptoms of Anxiety

The Beck Anxiety Inventory (BAI; Beck et al., 1988) is a 21-item self-report measure of anxiety. Examples of items include: "Fear of worst happening" and "Dizzy or lightheaded". Responses were rated on a 4-point Likert-scale (0 = *not at all*; 4 = *severely – it*

bothered me a lot) over the past month. Higher scores indicated greater severity of anxiety (i.e. score of 0-21 = low anxiety; 22-35 = moderate anxiety; ≥36 = potentially concerning levels of anxiety). The present sample demonstrated high internal consistency (α = .95).

Symptoms of Depression

The Patient Health Questionnaire (PHQ-9; Spitzer et al., 1999) is a 9-item self-report screener for the presence and severity of depression. Examples of items include: "Feeling down, depressed or hopeless" and "Poor appetite or overeating". Responses were rated on a 4-point Likert-scale (0 = *not at all*; 4 = *nearly everyday*) over the past two weeks. A score of 10 or above is indicative of the presence of depression. In the present sample, this measure showed high internal consistency (α = .90).

Symptoms of Stress

The Perceived Stress Scales (PSS; Cohen et al., 1983) is a 10-item measure that assesses for stress. Examples of items include: "In the last month, how often have you been able to control irritations in your life?" and "In the last month, how often have you felt that things were going your way?". Responses were rated on a 5-point Likert-scale (1 = *never*; 5 = *very often*) over the past month. Higher scores indicated higher levels of perceived stress (i.e. score of 0-13 = low stress; 14-26 = moderate stress; 27-40 = high perceived stress). Internal consistency was low in the current sample (α = .38).

Screen Time

Adapted from the Common Sense Media's Screen Time survey (Rideout, 2013), parents were asked how much time in hours they spend with handheld devices (iPad, tablet, smartphones and/or similar) on a typical weekday and weekend day. Parents were then asked a similar question to report on their child's ST. To calculate ST for parents and children, weekday times were multiplied by 5 and weekend day times were multiplied by 2, and thus

summed together. This amount of was divided by 7 in order to calculate the average daily ST use. In addition, the survey consisted of three additional binary questions relating to the impacts of COVID-19 on the amount of ST, children's wellbeing and activities/content viewed on ST.

Internalising and Externalising Symptoms

The Child Behaviour Checklist, 1-4.5 and 6-18 years old, (CBCL; Achenbach & Rescorla, 2000; Achenbach & Rescorla, 2001) is a parent-completed questionnaire regarding emotional, social, and behavioural difficulties within the last six months. The form for younger children contains 99 items, whereas the older children form consists of 118 items. It consists of three main scales: internalising (e.g. "whining", "sulks a lot"), externalising ("restless", "easily frustrated"), and other problems (e.g. "cruel to animals", "overeating"). In addition, six syndrome subscales can also be calculated (i.e. emotionally reactive, anxious/depressed, somatic complaints, withdrawn, sleep problems, attention problems aggressive problems). A total problems score can be computed by summing the internalising and externalising problems score. In the present study, two subscales were produced, one for internalising symptoms and one for externalising problems. Parents responded to items on a 3-point Likert-scale (0 = *not true*; 2 = *very true*) over the past six months. A higher score represents higher severity on each subscale. Internal consistency was high in the present sample (α = .98).

Procedure

The study protocol was approved by an ethical review board under the Australian NHMRC (National Health and Medical Research Council, 2018) Guidelines for the Conduct of Research with Humans. Informed consent was obtained from participants prior to completing the study. Participants completed a battery of questionnaires administered online

via Qualtrics, which took approximately 20 minutes to complete. Approximately 18 months later, participants completed a follow-up questionnaire consisting of similar questions.

Analysis Plan

Within the final sample, six cases (5.9%) were missing on both child internalising and externalising symptoms at T2, as parents did not complete this part of the survey. SPSS statistical software was used to impute the missing data. Thirty imputations were performed on the current dataset in order to reduce sampling variability from the imputation process (Sterne et al., 2009). Predictive mean matching was used to impute data. All variables in the main analysis model as well as three auxiliary variables pertaining to the impacts of COVID-19 were included in the imputed datatset. Non-normal distributed data was dealt with using predictive mean matching in the imputation process. A bivariate correlation analysis was conducted to examine initial associations between interested variables in the model.

A linear regression model was conducted to test whether parental mental health and parental and child ST predicted child outcomes across time. Independent variables measured at the initial timepoint (i.e. T1) consisted of: parental anxiety, parental depression, parental stress, parental ST and child ST child internalising symptoms and child externalising symptoms. Dependent variables were measured at follow-up (i.e. T2) which included: child internalising and child externalising symptoms. Covariates, also measured at T1, were: parental age, child gender, employment status, relationship status, annual household income and highest education level of parent. Two separate models were conducted where both models included all independent variables and covariates. The first model contained child internalising symptoms at T2 as a dependent variable, whereas the second model consisted of child externalising symptoms at T2 as a dependent variable.

Results

Table 1 demonstrates the descriptive statistics of parental mental health, parental and child ST and child outcomes. To examine the relationships of the key variables, we undertook bivariate correlation analyses, as shown in Table 2. There were strong correlations between measures at T1 and T2. At T1, all parental mental health measures and child ST were significantly and positively associated with child internalising and externalising problems at T2. That is, the more symptoms of depression, anxiety and stress experienced by the parent, as well as increased child ST at T1, the more internalising and externalising symptoms were present in children at T2. In addition, child internalising problems at T1 was positively and strongly associated with child externalising problems at T1, and this relationship was the same at T2. Specific to T1, parental anxiety showed a significant and positive association with parental depression, parental stress, parental ST and child ST. At T1, parental depression was also significantly and positively associated with both parental stress and parental ST, as well, parental stress was significantly and positively associated with parental ST.

Table 1: Descriptive Statistics of Key Study Variables

Study Variable	**N**	**%**
Parental anxiety T1		
Low	31	30.7
Moderate	64	63.4
Concerning	6	5.9
Parental depression T1		
Minimal or none	16	15.8
Mild	85	84.2
Moderate	0	0
Moderately severe	0	0
Severe	0	0
Parental stress T1		
Low	0	0
Moderate	56	55.4
High	45	44.6
Parental ST T1		
>2 hrs	36	35.6
<2 hrs	65	64.4
Child ST T1		
>1 hr	23	22.8
<1 hr	78	77.2

Study Variable	N	%
Child internalising problems T1		
Normal	95	94.1
Borderline	2	2
Clinical	4	4
Child externalising problems T1		
Normal	95	94.1
Borderline	2	2
Clinical	4	4
Child internalising problems T1		
Normal	78	77.2
Borderline	6	5.9
Clinical	11	10.9
Child externalising problems T1		
Normal	94	93.1
Borderline	0	0
Clinical	1	1

Key. For symptoms of anxiety, a score of 0-21 = low anxiety, 22-35 = moderate anxiety, and ≥36 = potentially concerning levels of anxiety. For symptoms of depression, a score of 0-4 = minimal or none, 5-9 = mild, 10-14 = moderate, 15-19 = moderately severe, and 20-27 = severe. For symptoms of stress, a score of 0-13 = low stress, 14-26 = moderate stress, and 27-40 = high perceived stress. For internalising problems, a score of 0-13 = normal, 14-17 = borderline, and >18 = clinical. For externalising problems, a score of 0-20 = normal, 21-24 = borderline, and >25 = clinical. Six cases were missing for each of these variables: child internalising and externalising symptoms at T2.

Table 2: Bivariate Correlations among Key Study Variables and Covariates (N = 101)

Variable	Mean (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
13. T1 Parental Anxiety	25.17(7.49)	1														
14. T1 Parental Depression	12.52(3.91)	.78**	1													
15. T1 Parental Stress	25.87(3.82)	.47**	.47**	1												
16. T1 Parental Screen Time	2.62(1.74)	.33**	.39**	.30**	1											
17. T1 Child Screen Time	1.41(.86)	.29**	.17	.07	.25*	1										
18. T1 Child Internalising Problems	5.54(10.53)	.07	.17	.01	-.04	.13	1									
19. T1 Child Externalising Problems	6.2(9.04)	.09	.16	.12	-.03	.10	.86**	1								
20. T2 Child Internalising Problems	10.48(8.13)	.69**	58**	.26*	.19	.27**	.00	-.02	1							
21. T2 Child Externalising Problems	5.36(7.71)	.72**	.67**	.26**	.20*	.26**	.11	.16	.80**	1						
22. Parent Age	37.55(4.14)	-.12	-.13	-.03	-.22*	-.04	-.10	-.11	-.16	-.25*	1					
23. Child Gender		.14	.18	.03	.05	-.05	-.05	-.10	.23*	.10	.02	1				
24. Highest Education Level		.00	.01	.04	-.19	-.05	.05	.05	-.04	-.03	.03	.01	1			
25. Annual Household Income		-.12	-.08	-.05	-.15	-.05	-.05	-.02	-.10	-.20	.19	.05	.22**	1		
26. Employment Status		.11	.08	.10	-.01	-.01	.23*	.24*	.08	.04	-.03	.04	-.26**	-.22*	1	
27. Relationship Status		-.04	.07	.05	-.11	.03	-.19	-.17	-.09	.01	.02	-.09	.02	.17	.20*	1

Note. Correlations between ordinal variables, and ordinal variables with continuous variables are Spearman rank correlation.

*p < 0.05 ** p < 0.01

In regard to covariates, parental age was significantly and negatively associated with both parental ST at T1 and child externalising problems at T2. That is, the younger the parent the more likely the parent was engaging in ST at T1 and increased child externalising problems were present at T2. Child female gender was significantly and positively associated with child internalising problems at T2, which indicated that females were more likely to exhibit such problems. Annual household income showed a significant and positive association with highest education level obtained by the parent. As annual household income increases, it was more likely that the parent held a higher level of education level, such as university qualifications. Employment status was significantly and positively associated with child internalising and externalising problems at T1 and was significantly and negatively associated with highest educational level obtained by the parent and annual household income. Lastly, relationship status had a significant and positive association with employment status.

Table 3 and 4 demonstrate the results from the linear regression models. In the first model (See Table 3), parental anxiety at T1 significantly predicted child internalising symptoms at T2 ($B=0.551$, $t(1)=3.89$, $p <.001$). This indicated that for every unit of increase in parental anxiety at T1, child internalising symptoms at T2 increased by 0.551 units. Interestingly, parental depression at T1 achieved close to statistical significance in predicting child internalising symptoms at T2 ($B= 0.521$, $t(1)=1.90$, $p = .057$). In addition, parental stress, parental ST, child ST, child internalising symptoms, and all of the covariates at T1 did not significantly predict child internalising symptoms at T2.

Table 3: Results from Linear Regression with Internalising Symptoms as the Dependent Variable

Variable	B	SE	t	p
Child Gender	0.67	1.29	0.51	.61
Parent Age	-0.15	0.16	-0.97	.33
Employed vs. Unemployed	-2.14	1.62	-1.32	.19
Currently Married vs Unmarried	2.17	1.80	1.21	.23
Parent Education Level (Completed university-level education)*				
Parent Education Level (Completed Y12 Cert)	-3.11	2.21	-1.41	.16
Parent Education Level (Completed Diploma/TAFE)	-1.38	1.77	-0.78	.44
Annual Household Income (<$100,000)*				
Annual Household Income ($100,000-$150,000)	-0.29	1.82	-0.16	.87
Annual Household Income ($150,000-$200,000)	-1.16	1.73	-0.67	.50
Annual Household Income (>$200,000)	0.31	2.00	0.16	.88
Parental Screen Time	-0.56	0.43	-1.30	.20
Child Screen Time	1.08	0.77	1.41	.16
Parental Anxiety	0.55	0.14	3.89	.00
Parental Depression	0.53	0.28	1.90	.06
Parental Stress	-0.17	0.19	-0.88	.38
Child Internalising Symptoms	-0.10	0.06	-1.58	.11

Key. Y12 Cert = Year 12 Certificate.
*Reference category

Table 4: Results from Linear Regression with Externalising Symptoms as the Dependent Variable

Variable	B	SE	t	p
Child Gender	.41	1.13	.36	.72
Parent Age	-.32	.14	-2.26	.02
Employed vs. Unemployed	.92	1.40	.66	.51
Currently Married vs Unmarried	.21	1.54	.14	.89
Parent Education Level (Completed university-level education)*				
Parent Education Level (Completed Y12 Cert)	-2.89	1.95	-1.48	.14
Parent Education Level (Completed Diploma/TAFE)	-.62	1.55	-.40	.69
Annual Household Income (<$100,000)*				
Annual Household Income ($100,000-$150,000)	-.86	1.69	-.51	.61
Annual Household Income ($150,000-$200,000)	-.79	1.62	-.48	.63
Annual Household Income (>$200,000)	.79	1.62	-.49	.63
Parental Screen Time	-.43	.35	-1.22	.22
Child Screen Time	.67	.64	1.04	.30
Parental Anxiety	.50	.12	4.31	.00
Parental Depression	.73	.23	3.21	.00
Parental Stress	-.23	.16	-1.43	.15
Child Externalising Symptoms	.00	.06	.07	.94

Key. Y12 Cert = Year 12 Certificate.
*Reference category

In the second model (See Table 4), parental anxiety and parental depression at T1 significantly predicted child internalising symptoms at T2 (B=0.481, t(1)=4.31, p <.001; B=0.654, t(1)=3.21, p = .001, respectively). These results suggested that for every unit of increase in parental anxiety and depression at T1, child internalising symptoms at T2 increases by 0.481 and 0.654 units, respectively. Similarly, to the previous model, parental stress, parental ST, child ST, child externalising symptoms, did not significantly predict child internalising symptoms at T2. However, only one covariate, parent age, significantly predicted child internalising symptoms at T2 (B=-0.317, t(1)=-2.61, p = .024). That is, for every unit of increase in parental age, child internalising symptoms at T2 decreases by 0.317 units.

Discussion

This study aimed to investigate the relationships between parental mental health, parental and child ST and child internalising and externalising problems. The findings provided partial support for the initial hypothesis where increased symptoms of parental mental health and greater parental ST predicted child internalising and externalising symptoms across time. Specifically, parental anxiety at T1 predicted child internalising symptoms at T2. Furthermore, both parental anxiety and depression at T1 significantly predicted child externalising symptoms at T2. However, the study did not provide support for the second hypothesis, in which greater child ST did not predict child internalising and externalising symptoms across time.

Taken together, the findings indicated that parental mental health was significantly associated with poorer temporal child outcomes. This supported findings in previous longitudinal studies in various age samples (Bouvette-Turcot et al., 2017; Elgar et al., 2007; Goodman et al., 2011). Bouvette-Turcot et al. (2017) examined parental mental health by

assessing for perceived stress and psychiatric symptoms, whereas Elgar et al. (2007) and Goodman et al. (2011) solely explored depressive symptoms. A strength of the present study is that the effects of parental mental health on child outcomes was accounted by distinct categories, which included symptoms of depression, anxiety and perceived stress. Interestingly, when parental mental health was accounted for in the same model, ST was not predictive of such temporal child outcomes. These findings were in contradiction to previous studies of adolescent samples (Costigan et al., 2013; Perrino et al., 2019) that have found negative associations between ST and temporal child outcomes. The results from the present study further reflect the current ambiguous findings within in the field, particularly studies that have examined primary-school children (Hosokawa, 2018; Liu et al., 2016; Suchert et al., 2015). These conflicting findings illustrate that more research needs to be conducted to ensure consistency and clarity regarding the emotional and behavioural changes in children's development across time. However, it is worth highlighting that these previous studies did not consider parental mental health as a predictor, and this is a notable strength of the current study.

These present results represent a timely finding, as potential attitudes and use of ST has changed dramatically within the past several years. ST has been increasingly part of the norm, where children without a screen is rare. The use of handheld devices have been adopted into educational settings, used for a variety of purposes to assist parents with running errands and household chores (Kabali et al., 2015), and has been necessary for those transitioning to online learning during the COVID-19 pandemic, as well as maintaining connections with others during these isolated periods. Therefore, children have been thrust into a world where handheld devices have become a necessary and normal part of everyday life. Although this study did not find ST as a significant predictor of child outcomes, it may be a representation of the evolving change of the use and adoption of technology within this

"portable era". Attitudes and norms regarding screen usage have potentially changed given its daily presence in our lives, and therefore this may increase the normality of its use.

The present study was able to consider the simultaneous effect of parental mental health and ST on child outcomes. Indeed, it was anticipated that parents who present with mental health difficulties and had high levels of ST were more likely to have children who present with greater internalising and externalising symptoms. This may be because these parents may have limited capacity to attend to their child's needs and ST may displace these crucial parent-child interactions, which is already difficult for this population of parents. However, this study could not provide evidence for both parental health and ST as significant predictors of child outcomes. One explanation for these conflicting results is that there may not have been adequate power to detect an effect of this size, particularly as only half of participants responded for the follow-up study. Another interesting finding was that the majority of parents, and more so children, were meeting ST recommendations. Most children in this sample also fell within the "normal" range for both internalising and externalising symptoms at T1 and T2. Therefore, it is difficult to gauge if such effects exist for those on extreme ends of the spectrum.

This study solely examined handheld devices in order to extrapolate specific findings regarding these contemporary forms of ST. Handheld devices first appeared approximately ten years ago in our lives, and at this time, they have become normalised and ingrained into children's lives. Because of this, and particularly the age group considered in this study, parents are consistently concerned about the benefits and risks of engagement with handheld devices and exposed to recommended guidelines for the use of these devices. Moreover, it may be useful for parents to have mobile applications that details screen guidelines and strategies to meet those guidelines relevant to a child's age and stage of development. The results suggest that although it is unclear of the benefits of these devices, it appears that when

children are adhering to ST guidelines, there is a less likelihood for adverse outcomes. In fact, parental anxiety and depression were a more concerning factor to children's outcomes and should be considered as targets for early intervention. Parenting programs that address stressors or issues relevant to young parents and that can be easily accessed from a handheld device may mean that screens are utilised for beneficial purposes.

Limitations of the present research should be considered. Mono-method biased may be a potential limitation, where parents answering the same question about their own screen use, immediately followed by their child's use may influence the association between these two variables. However, parents generally spend the most time with their children and make the decisions for their child, and therefore they are most fit to answer questions regarding a child's screen time. Given the longitudinal nature of the study, it would have benefited from an increased initial sample to compensate for attrition. Although the researchers attempted to recruit from several sources, the follow-up data was collected during the first year of the COVID-19 pandemic, and so was inevitably out of the control of the researchers. Because of this, parents may have had other stressors and strains to be able to participate at T2. In addition, as all participants were from an Australian context, covariates related to COVID-19 were considered, however did not show any difference to primary analyses. This may be because follow-up data was initially collected when Australia was no longer in formal lockdown. Furthermore, a broader sample of the population may have captured children who were not meeting ST guidelines and those of borderline/clinical range for internalising and externalising symptoms. Interestingly, it may be that certain parents who express interest to participate in these studies may have children with less emotional or behavioural difficulties or less competing demands.

Early life experiences and parental influences are key contributors towards shaping and moulding temporal outcomes for children. Children thrive when they receive positive

nurturance, warmth and supportive parenting, alongside developmentally appropriate activities and healthy lifestyle habits. This study has demonstrated that parental mental health has a significant influence towards children's longer term outcomes, after controlling for the effects of ST in both parents and children. Future studies should consider establishing early intervention programs directed towards improving the mental health of parents of young children, particularly given that the period of entering formal school is sensitive to development. Although this study did not find harmful effects of ST on child outcomes, future studies could benefit from examining a wider pool of young children and capturing those who do engage in excessive ST. These studies could also consider the context and content of ST viewed on children's outcomes, as this still represents a gap in the literature. Furthermore, this study has highlighted that current health recommendations regarding ST is helpful in minimising harm to children's development. Children learn rapidly from their parents, and thus it is vital that parents have positive mental health in order to model healthy habits, such as ST, in order to give their children the best outcomes in life.

CHAPTER 7: General Discussion & Conclusion

The nature of ST has evolved considerably over the past decade, due to the introduction of more portable and accessible devices, namely smartphones, iPads, tablets and similar devices. Children now spend significantly more time with such devices, and although parents are key influencers of a child's screen habits in the early years, the effects of parental mental health within this context and its implications for child developmental outcomes are relatively unknown. This thesis aimed to examine the relationship between parental mental health and other parental characteristics and child ST, and to investigate the effects of ST on children's developmental outcomes. Chapter 7 will begin with a brief summary of the results, followed by a deeper discussion drawing in pertinent theories and clinical implications. The strengths and limitations will be outlined and, finally, potential future directions and a general conclusion will be presented.

Summary of Results

With the rapid evolution of handheld devices, it has become important to regularly review their impact. While there is substantial evidence that has investigated use of traditional forms of ST, such as TV, computers and gaming consoles, more contemporary and handheld devices have become of interest only within the last decade. In the context of this thesis, previous systematic reviews of ST have found studies that either explored parental characteristics associated solely with traditional ST or that grouped traditional ST with handheld ST (Duch et al., 2013; Hoyos Cillero & Jago, 2010; Xu et al., 2015). Research that has investigated parental characteristics associated with handheld ST or with subsequent developmental outcomes has reported mixed results, highlighting a need for further research to verify, confirm and strengthen results (Park et al., 2018; Rocha & Nunes, 2020). Methodologically, a large proportion of this research has used cross-sectional designs,

limiting its ability to capture developmental changes over time (Paudel et al., 2017). Mounting evidence of children exceeding the recommended daily ST limits has motivated researchers to examine the implications of increasing screen use (Brug et al., 2012; Houghton et al., 2015; Kristiansen et al., 2013; Melkevik et al., 2010). This review concluded that, amongst other results, that as children are particularly vulnerable in the early years of life and their developmental changes occur rapidly, a longitudinal design would be a better approach for examining this thesis topic as it can potentially measure the effects of ST and the patterns of change across time.

Collectively, the evidence reported by this thesis demonstrated the facilitative effects of a parent or carer on ST habits and behaviours in children aged up to eight years, as well as the effects of ST on subsequent developmental outcomes, such as increased emotional dysregulation, withdrawal, aggression, hyperactivity, conduct problems and inattention. In Chapter 2, the findings from study one, a longitudinal design, were reported, capturing the temporal effects of traditional ST on children's academic outcomes over the immediate period after handheld devices were introduced, namely from 2008 to 2015. These results showed that greater ST leads to decreased performance in academic achievement across time, although this was not observed across all domains of learning examined. Previous longitudinal studies had focused on adolescent cohorts (Johnson et al., 2007; Nelson et al., 2006; Poulain, Peschel, et al., 2018), but this longitudinal study tracked an earlier time period in childhood development; from when children first enter formal schooling through to the final months of primary schooling. This study also utilised the NAPLAN, a standardised measure of academic achievement in the areas of reading, writing, numeracy, spelling and grammar/punctuation, and thus it is relevant and generalisable to an Australian population.

In study two, presented in Chapter 3, a systematic review that included 20 studies was conducted on evidence relating to handheld device use over the past decade. It ascertained

that increased child handheld ST is associated with more positive parental attitudes towards and behaviours surrounding screen use, decreased parental limit-setting and self-efficacy in setting limits, decreased parental wellbeing characteristics, lack of parental availability and permissive parenting styles. These findings were consistent with previous research (Duch et al., 2013; Hoyos Cillero & Jago, 2010; Xu et al., 2015), and they confirmed that parents are key influencers in establishing and maintaining screen habits in children. Most studies reported an association between more child handheld ST and poorer developmental outcomes, including greater internalising and externalising problems, such as increased emotional dysregulation, withdrawal, aggression, hyperactivity, conduct problems and inattention. These results were interpreted with caution given that only five studies were extracted. It was also difficult to determine the causality and temporal trends of findings as only two studies were longitudinal in nature. Overall, the review demonstrated that there are a limited number of longitudinal studies in the field, parental mental health has not been extensively explored in the context of ST, and more research is needed to clarify the associations between child handheld ST and developmental outcomes in children.

Study three, presented in Chapter 5, used a cross-sectional design, with the aim of building on the previous research and expanding it to include contemporary handheld devices, while also considering parental mental health, which has not been deeply explored in previous studies. The results from study three added new knowledge to the field by showing that parental anxiety, depression and stress are significantly associated with parental smartphone use, such that more pronounced symptoms of these mental health issues are associated with increased parental ST. Parental anxiety was also associated with increased parental tablet use, as well as increased child phone and tablet use. In addition, both parental phone and tablet use were strongly and positively associated with both increased child phone and tablet use. Further analyses showed that mediation effects were not observed among key

variables. Interestingly, most parents reported adherence to ST guidelines by their children, and a large majority of the sample of children fell within the normal range for internalising and externalising problems. One potential explanation is that children in this age group tend to have less access to and ownership of devices than older children, and as a result engage in less screen time. In this study, approximately two-thirds of children owned a tablet/iPad and only 2.3% owned a smartphone. Another explanation is that most parents within this sample were from high SES backgrounds, and potentially more able to easily access and implement preventative health messages than parents from low SES backgrounds. Therefore, this may result in their children meeting ST guidelines and showing fewer internalising and externalising problems.

Finally, study four, a longitudinal design study presented in Chapter 6, expanded on prior studies in the thesis to incorporate aspects of parental mental health and changes in the child's developmental trajectory on entering and during the primary schooling period. Data on parental health measures, and on parental and child ST, were collected when children entered primary school. In addition, outcomes that measured internalising and externalising symptoms were collected when children had had at least one year of primary schooling. Responses to additional binary questions relating to the effects of COVID-19 on screen usage were collected. These results found that 74.3% of parents reported that children's ST had increased during COVID-19. However, only a third of parents reported that they had noticed changes in their child's wellbeing due to this increased ST, with 36.6% reporting that COVID-19 had changed the activities and content viewed on their children's screens. The results concluded that parental anxiety significantly predicted child internalising symptoms over a period of approximately eighteen months. Parental anxiety and depression also significantly predicted child externalising symptoms over the same period. However, the study found that parental and child ST did not significantly predict child internalising and

externalising symptoms. These findings concluded that parental mental health is predictive of temporal child outcomes and accounts for a greater proportion of variance after controlling for ST.

Theoretical Implications

This thesis adds to the theoretical base for the ST literature in several valuable ways. According to the bioecological theory (Bronfenbrenner, 1979), the microsystem has the greatest influence on a child's development, and involves the child's family, peers and school. Therefore, parental mental health and children's exposure to screens as a result of modelling of parental screen behaviour are likely to influence children's activities and outcomes. The current field contained a lack of studies that explored parental mental health and ST. This thesis was able to address this important gap in the literature by considering the interrelationships between parental mental health and ST and its impacts on children.

The cross-sectional study, study three, suggested that certain markers of parental mental health may affect the amount of ST engagement by parents and children. In particular, parental anxiety was a significant predictor of both parental and child ST; however, only parental depression and anxiety had a significant association with parental ST. The increased use of handheld devices by parents may be due to it being a way of coping with daily stressors, balancing the demands of parenting and parental mental health needs, and managing their child's distress and undesirable behaviour. Previous research by Tang et al. (2021) observed a stronger relationship between depression and handheld devices than with traditional forms of technology such as TV and video games. One potential explanation is that handheld devices are more interactive and interpersonal than passive and consumption-oriented traditional ST. Moreover, in that study, ST had a stronger association with depressive symptoms than with anxiety (Tang et al., 2021). This contradicts the findings of this thesis, where studies three and four both demonstrated that parental anxiety has the most

significant and strongest relationship with ST. It is likely that there are other potential mediators in this relationship that may account for this complexity. Therefore, future research that includes other potential mediators within this framework is needed to identify the complex interplay between specific symptoms of parental mental health and ST.

Consistent with the bioecological theory (Bronfenbrenner, 1979), the longitudinal study, study four, provided evidence for the effects of the mesosystem. After controlling for both parental and child ST, parental anxiety was found to be significantly associated with child internalising problems over time. In addition, both parental anxiety and depression were significantly associated with child externalising problems over time. These findings are consistent with previous literature which showed that anxious or depressed parents tend to have children who develop negative outcomes, such as increased risk of depression and anxiety (Eckshtain et al., 2018; Edwards et al., 2010), attachment insecurity (Toth et al., 2009), low social competence (Luoma et al., 2001), conduct problems (Chronis et al., 2007), and decreased school performance (Shen et al., 2016). This is an important advancement in knowledge as it suggests that handheld devices may act as a barrier to parent-child interactions, particularly for parents with mental health challenges, and thus potentially disrupt attachment processes, resulting in poorer outcomes for children.

Attachment theory proposed the importance of the emotional bonds formed between a parent and child in order to develop secure attachments (Bowlby, 1969). Attunement is an important process in attachment where a parent mirrors the emotional expression of their child, and is essential for communicating empathy and availability (Haft & Slade, 1989). Previous studies have suggested that parents with mental health difficulties have limited capacity to attune to their child's emotional needs (Borre & Kliewer, 2014; Bronte-Tinkew et al., 2007; Pape & Collins, 2011; Reupert et al., 2013), and if coupled with technological disruptions, this has significant implications for parent-child interactions and subsequent outcomes for children.

Studies three and four provided novel evidence to support these theoretical claims, and successfully examined the effects of specific symptoms of parental mental health on young children within the context of ST. Specifically, parents with mental health difficulties tend to gravitate towards using a screen, and that children are more likely to model this behaviour when they see their parents using screens. One implication is that the "screen" may act as an additional barrier to the development of a secure attachment, where parents struggling with mental health are already at a disadvantage.

As discussed earlier, Social Learning Theory (Bandura, 1977) proposed that children learn screen habits and behaviours by observing and imitating behaviour modelled by their parents. Children are surrounded by device use not only in their home environment, but also at school, in the playground, during visits to extended family and friends, in grocery stores and in waiting rooms at medical practices. Although there are other contexts in which children may learn ST behaviours, they spend the most time with their parents during primary school years, so it is inevitable that parents provide the scaffolding for such behaviours (Lauricella et al., 2015). In this way, the present research supports social learning theory.

Several studies in the systematic review demonstrated that parental ST is associated with child ST, as per study two, and also that as parental phone and tablet use increases, so does child phone and tablet use, as per study three. However, parental characteristics cannot be viewed in isolation from each other; on the contrary, certain parental characteristics are associated with each other, which may further account for the variance in child ST, as shown in study two. For instance, parental ST was shown to be closely associated with parental attitudes towards ST, with more positive attitudes more likely to see parents engage in greater ST, and parents who display more concern about ST more likely to apply ST limits. Collectively, when considering all the studies in this research, one can conclude that children learn ST habits from their parents, and that these effects may be amplified when parents have

mental health difficulties. However, potential confounders that may further contribute towards this relationship include parental education, annual household income, ethnicity or exposure to previous trauma.

It has been widely acknowledged that operant conditioning is a process that sees frequency of behaviour increase as a result of its consequences (Skinner, 1953), and this principle may also apply to ST. Parents using devices to reward or punish behaviour through reinforcement strategies will ultimately shape and influence their child's behaviour, as well as their ST habits. For example, parents may reward children with ST contingent on them displaying desirable behaviour or complying with a request, with ST acting as a positive reinforcer. By contrast, parents may more readily give their child a handheld device when their child is distressed or displaying undesirable behaviour (e.g. a tantrum), in an attempt to moderate or cease that behaviour. In this case, ST acts as a negative reinforcer, and over time children may reproduce that negative behaviour, having learnt that their parent will give in to their demands. In line with family coercive processes, a parent may unintentionally reinforce their child's misbehaviour, which can lead to further parental aggression and demands for compliance, resulting in further child misbehaviour, and so forth, until either the parent or the child surrenders (Patterson, 1982). Children may also attempt to behave in a way that prevents their device being taken away or their ST being reduced.

Although this study did not directly investigate the chain analyses of child behaviour in response to parents, the investigation did result in an interesting incidental finding. In study three, around 36% of parents rewarded children with a device for desirable behaviour, and approximately a third of parents used devices to keep their child calm in public places. This was consistent with results from the systematic review, namely study two, which identified that several parents used screens as a reward or punishment tool for behaviour (Bentley et al., 2016; Guedes et al., 2020; Kabali et al., 2015; Kulakci-Altintas, 2019; Seo & Lee, 2017).

However, guidelines developed by health experts recommend that parents should reward children for desirable behaviour not with ST, but instead with more active family time (Department of Health, 2021). Therefore, it would be worthwhile to explore whether parents with poor mental health may be inclined to deploy these forms of discipline, and to consider how parents can discipline their children without using ST in order to shape their learning of positive behaviours.

Clinical Implications

The present findings have a number of implications for interventions for and prevention of unhealthy screen use and consequent poor developmental outcomes in children. Technology has long been used to assist children with learning in classrooms, and the range of educational material that can now be accessed on handheld devices has changed how screens are utilised for educational purposes. Study one helped to further enhance our understanding of the widely researched area of the impacts of traditional ST on academic achievement, in order to inform potential findings for handheld devices. Study one established that excessive screen use has detrimental outcomes for academic achievement over time. Although this was specific to traditional forms of ST, it was able to demonstrate that these effects can occur across 3-5 years (i.e. a medium-term effect) as well as across 5-7 years (i.e. a long-term effect). These findings support the strong bias of the negative effects of ST that is currently present within the field.

In contrast to the findings from study one, handheld devices have facilitated online learning, as well as constituting an additional platform for school learning more generally. Study four was conducted during the period where handheld devices were utilised for home learning as COVID-19 restrictions were enforced. Previous research found that these devices can enhance learning, and increase motivation and knowledge acquisition (Furió et al., 2015),

as well as enquiry-based learning (Hennessy et al., 2015). Handheld devices have enabled children to learn from home, which traditional ST may not have accomplished as effectively. Therefore, it is possible that handheld devices have benefited academic achievement, particularly during the COVID-19 pandemic. However, this is not evidently clear from the current research and cannot be conclusively determined. While these devices may enhance children's learning experiences, this does not necessarily translate into improved learning outcomes. It will depend on the content that children are viewing during their recreational ST, and how screen use is regulated in the family home. In addition, sleep may be a confounding factor that was not considered within this relationship. Previous research has identified that exposure to screens is associated with shorter sleep duration, where poor sleep has been related to decreased academic performance and increased emotional and behavioural problems (Faught et al., 2017; Wu et al., 2017). Longitudinal research specific to educational learning and the consideration of sleep, as well as large-scale evaluations of programs utilising devices, may better capture the long-term outcomes for children's academic performance and overall wellbeing.

The lockdown restrictions due to COVID-19 has seen an upsurge in young children engaging with screens, and the effects of this are as yet unknown. When Australia was first locked down in March 2020, children in this research transitioned to online learning. Study one demonstrated the impacts of screens in academic settings, and the long-term effects of the pandemic and ST on children's outcomes have become growing area of interest for researchers. To date, different Australian states, like other parts of the world, have moved in and out of lockdown. Although children have spent more time on screens for educational purposes, it is likely that their recreational screen use has also increased. With more time spent indoors, children may have been more inclined to use screens to occupy their time and keep themselves entertained, and parents in a similar situation may very well have modelled

this behaviour. With overall screen use thus increasing, this may have consequences for children and for the interpretation of this thesis.

One example is the impact on the development of children's social skills. During COVID-19, children have had fewer opportunities to socialise with teachers and peers in the classroom and playground, instead interacting with them through a screen. On the one hand, handheld devices have touchscreen interactive features which enable children to swipe and elicit an interesting response, sound or effect (Troseth et al., 2016). On the other hand, children may be less likely to receive live and interactive feedback in the shape of social cues, and may miss these cues, which include body language, physical distance and facial expressions. Video models also cannot respond contingently to a child (Troseth et al., 2016). Live video calling, which has become popular during COVID-19, may mitigate some of these effects, but not all social cues can be effectively communicated through a screen. It is vital that research keeps pace with advancing technology, particularly as the associated effects of COVID-19 become more pronounced over the next decade.

The systematic review, study two, demonstrated that parents shape and facilitate healthy screen habits, and can do so through adherence to guidelines, ideally beginning to shape these habits in a child's early years. Study two provided strong evidence, consistent with previous literature (Duch et al., 2013; Hoyos Cillero & Jago, 2010; Paudel et al., 2017), for a range of parental characteristics that contribute towards increased screen use among children. This review also highlighted reasons why parents continue to facilitate ST despite being aware of the potential negative consequences. These reasons include the perceived educational benefits of screens, parents using screens as an "electronic babysitter" or to keep children occupied while they run errands or perform household duties, or using them as a reward/punishment tool for behaviour (Baek et al., 2013; Bentley et al., 2016). COVID-19 has stretched the mental resources and time of many parents, particularly those who have had

to supervise online teaching for their children. Attitudes towards screens may have changed significantly during this pandemic, increasing the appeal of allowing children to use screens. ST has become necessary and even essential for maintaining academic studies, coping through isolation and staying in contact with loved ones.

Although there is large focus on the negative implications of handheld devices, there is a potential for these devices to effectively treat mental health issues. The current literature represents a growing area where an increasing number of smartphone applications and e-mental health interventions targeted towards improving mood or physical activity have been widely available (Akgün et al., 2019). This may be a preferred method of treatment for parents who have limited time and resources given its accessibility, lower costs, flexibility, and level of control over treatment (Struthers et al., 2015). The cross-sectional, study three, suggested that parents with poor mental health may be more prone to use devices as a way to cope with the competing demands of parenting and their own mental health. However, if these devices were harnessed as a tool to enhance mental health within parents then this may have positive outcomes for effective parenting. Indeed, previous research investigating the efficacy of the *'Home-but-not-Alone,* a postnatal psychoeducational program delivered through a smartphone application, found that parents reported improvements in parental self-efficacy, social support and parenting satisfaction (Shorey et al., 2017). In addition, these devices may provide another platform in accessing parenting resources and education, where this has been increasingly popular among pregnant women (Buchanan et al., 2021). Specifically, creating an e-mental health intervention that contains psychoeducation on mental health and its relation to parenting, strategies to reduce stress and improve wellbeing, and a chat feature for parents to speak to a mental health professional. This intervention could contain common topics of interest for parents, where a section on regulating children's ST and addressing related emotional or behavioural issues would be beneficial. This enables

the parent to easily access mental health resources in the comfort of their home especially given their increased demands. Previous research has established that interventions to change lifestyle behaviours are more effective when parents are involved (McLean et al., 2003; Niemeier et al., 2012). Interventions to reduce ST and encourage healthy screen behaviours are likely to be more effective if parents are not only involved but also provided with psychoeducation about healthy practices. Studies three and four suggested that parents with mental health difficulties are a highly vulnerable group in terms of children's outcomes, and therefore an important target for early intervention and prevention. One interesting finding from the longitudinal study (study four) was that parental mental health is a more significant contributor than ST to children's outcomes. Parenting programs focused on improving parents' mental health, while also providing them with accessible guidelines, would bring more beneficial outcomes for children. Each guideline could be paired with a strategy so that it enables the parent to more easily meet these guidelines. For example, in regards to monitoring how screens are used, technical instructions for various devices or a list of applications could be given, as well as behavioural strategies to monitor children's activity.

As discussed earlier, many children are exceeding the two-hour daily ST limit recommended by health experts, and therefore potentially risking harming their developmental outcomes (Brug et al., 2012; Houghton et al., 2015; Yu & Baxter, 2016). For instance, prior studies have reported that children who engage in excessive ST, above the guideline recommendations, are more likely to display negative developmental outcomes, such as increased emotional symptoms and conduct problems, reduced prosocial behaviour, hyperactivity, and greater peer problems (Genc, 2014; Wu et al., 2017). This thesis was able to provide some support for current health recommendations regarding ST use. In particular, study four demonstrated that when parents report that their children are adhering to the guidelines, it appears that the likelihood of harmful outcomes decreases, particularly in

relation to internalising and externalising behaviours across time. It is important to note that this study had a limited number of participants at the far end of the spectrum, namely children engaging in excessive screen use. Thus, it is difficult to compare findings relating to those children who are meeting the guidelines to those who are not. Similarly to prior studies, it is also difficult to specify the particular content viewed on screens that leads to these outcomes. Therefore, health experts need to ensure that guidelines consider ST content, as well as being accessible and adaptable to the family home, and appropriate for the age and developmental stage of a child.

Strengths of the Present Research

The present research has a number of strengths, and has added value to the current ST literature. As technology continues to evolve, findings on the impacts of handheld devices, rather than compared with traditional forms of ST, are timely. These devices have revolutionised the ways children communicate with others, share information, learn about and understand the world, and are exposed to people, places, animals and objects that they would be otherwise unable to see (Kai Yee et al., 2019). Handheld devices have interactive features, and can be accessed across multiple contexts, in contrast to the passive viewing and stationary contexts associated with traditional ST (Lauricella et al., 2015). Study two captured a systematic review of the literature specific to handheld devices. This review set the scene for the cross-sectional study, study three, and the longitudinal study, study four. A notable strength of these two studies is their consideration of parental mental health in the context of ST. These studies were able to examine a specific population of parents who may be more sensitive to the effects of ST and its subsequent outcomes for children's development. Parents struggling with mental health issues may resort to screens as an "electronic babysitter" or to regulate their child's behaviour, rather than promoting healthy screen practices to facilitate optimal development.

It is widely known that children are now accessing and engaging with devices at a younger age. This thesis focused on a critical age cohort, 0-8 years old, which is characterised by sensitive periods of development. During sensitive periods, children are highly receptive to stimuli in their environment, more so than during earlier or later stages of development (Woodard & Pollak, 2020). Research on sensitive periods for social-emotional development has come largely from children growing up in atypical caregiving experiences such as institutions, or from children exposed to trauma. These children have shown disturbances in their autonomic nervous system functioning (Esposito et al., 2016), brain development, emotion regulation (Gee, 2016) and mental health (Wiik et al., 2011). Therefore, it is important that children receive appropriate stimulation from their environment to nurture a healthy development.

The focus on this age group is of the utmost importance, as health routines and practices, including ST, are highly malleable during early childhood, more so than later in life (Hamilton et al., 2016). Previous research has established that early screen exposure within this age cohort is formative. In particular, habits established early on may increase the likelihood of excessive use in later life (Canadian Paediatric Society, 2017). ST tends to be facilitated or discouraged by parents of children in this age group. Therefore, parents have the ability to create a healthy home media environment by encouraging use of those functions of screens that will benefit children's development and minimise the risks of negative consequences.

Another strength of this research is that it was able to provide evidence to account for a number of variables that may influence the amount of child ST. This can help to inform policy development and recommendations for future or revised guidelines for the use of screens by this age group. At this stage, guidelines recommend that parents model healthy screen use, limit screen use to certain periods, and have ongoing conversations with their

children about their use and viewing habits, including discussing content viewed (American Academy of Pediatrics, 2016a, 2016c; Department of Health, 2021). It is important, when investigating the effects of ST, to consider how different parental characteristics may influence or interact with children's screen habits, or may serve as a barrier. Guidelines and strategies to promote healthy screen practices should similarly take into account of the many parental characteristics that may affect screen use. Health experts need to consider not only exposure to and limits set on ST, but also family-focused interventions that can foster a home environment with healthy screen use. Based on the findings from this thesis, guidelines specifically tailored to parents with mental health issues would be beneficial. This population of parents may have difficulty modelling healthy ST behaviour and implementing child ST limits, therefore strategies need to be designed that take account of their reduced capacity to engage with their child.

Contradicting the negative bias in relation to ST in this research field, this thesis has demonstrated that not all ST is detrimental for children, particularly when guidelines are adhered to. A potential fruitful area for further policy development is the modification of guidelines to foster the benefits of ST and minimise its risks. With ST now the norm in children's lives, if ST were harnessed as a valuable educational and learning tool, as well as a medium for sharing information and increasing connection, then children would be likely to reap benefits. Moreover, a health star rating system based on a child's age and developmental stage could be a way to help parents to select content appropriate for their child.

A significant contribution of this present research is that studies one and four utilised longitudinal designs, thereby adding substantial value and new knowledge to the field. This research provided support for various predictors of ST by accounting for stability in the outcome variables, notably children's academic achievement and developmental outcomes over time. Study one captured data across three time points, while study two measured across

two time points. It takes time to learn behaviours such as ST, and time for the consequences to unfold. Although initial changes in behaviour may have a cumulative effect, a longer follow-up period as reflected in the current study will result in a more accurate account of long-term changes and how they may occur, in contrast to cross-sectional research (White & Arzi, 2005). Across the current studies, various methods of statistical analysis were employed to capture cross-sectional and longitudinal data. These included structural equational modelling, mediation analyses and linear regression models. Therefore, predictors and covariates, as well as intervening variables, were accounted for in the models.

Limitations of the Present Research and Future Directions

The present research has a number of limitations. Although this research aimed to utilise longitudinal designs, there were difficulties obtaining a large sample size and the attrition rate was higher than expected. A number of participants were lost to follow-up, which is a common phenomenon in longitudinal research given the length of time over which such studies are conducted (White & Arzi, 2005). Attempts were made to minimise these risks during the early phases of data collection by recruiting participants from multiple settings and outsourcing recruitment to external stakeholders. Data collection also occurred during the COVID-19 pandemic, which may have affected follow-up rates, although data were not collected during lockdown periods. The final sample size may have affected the amount of power needed to detect a significant effect among the findings. In addition, the data collected across these studies were not able to capture children falling at extreme ends of ST use, or those within the borderline/clinical range of internalising and externalising symptoms. Therefore, it may be difficult to comment on the outcomes of children who did not meet ST guidelines and engaged in excessive use.

Further regression analyses were conducted to determine whether differences in children's ST emerged when additional parental characteristics were accounted for (See Supplementary Table 3 in Appendix E). These predictors were: attitudes towards ST, ST limit-setting practices, perceived self-efficacy in relation to technology alongside parental mental health, parental ST, and parents' age, employment, marital status, highest educational level completed and annual household income. Interestingly, no significant findings were observed in this model. As mentioned earlier, this may be due to the absence of children captured at extreme ends of the spectrum, as well as low follow-up rates. Therefore, this research may not have involved a sample that was sufficiently representative of the general population. In addition, qualitative studies regarding parents' mental health and children's screen practices may have provided a more accurate representation of the predictors within this relationship.

Methodologically rigorous longitudinal studies will enable us to foresee growing patterns and trends of screen use across the developmental lifespan and their subsequent outcomes for children. Future studies could consider capturing a wider pool of children, which could increase the generalisability of the findings. With COVID-19, children have increased their screen use while also accessing handheld devices for educational content. Therefore, data collection at additional time points to monitor the long-term effects of screen use during the pandemic would be worthwhile.

In terms of the methodological design of the present study, it was limited to reliance on data reported by one parent. There was a lack of data reported by secondary parents, as well as of teacher observations of internalising and externalising behaviour in the classroom. In addition, there was an over-representation of data provided by mothers. Multiple informants, particularly from fathers, may increase the reliability and strength of findings and could be considered in future research. The majority of research findings was restricted to

handheld devices and did not include data TV and computer use and thus such findings may potentially be an overgeneralisation. Nevertheless, the primary aims of this research was to investigate the unique contributions of handheld devices. This research may also be subject to social desirability bias, in that the results may be confounded by the extent to which parents reported on key variables of interest, such as parental mental health, parent and child ST, and child internalising or externalising behaviour. However, the majority of research on ST relies heavily on subjective reported data (Duch et al., 2013; Paudel et al., 2017). At this stage, there are limited tools for objectively measuring ST. Measurement devices such as wearable cameras may offer more precision for measuring the amount of screen exposure and the content viewed (Sanders et al., 2019). However, there are limitations with wearable cameras such as ethical constraints of when cameras are worn, the feasibility of a child wearing a camera for extended periods of time, as well as errors in coding and interpreting the data given that large amounts of data will be obtained.

Handheld devices have become increasingly popular and widely used in educational settings. The COVID-19 pandemic has witnessed a significant uptake of screens for online learning as well as recreation, with children obliged to stay at home. Indeed, research on five to eight-year-olds has confirmed that children's recreational screen use has increased by one hour a week on average, compared with pre-pandemic times (McArthur et al., 2021). Although study one identified that traditional forms of ST have negative consequences for academic achievement, this study did not distinguish between screens used for educational and recreational purposes, or ascertain the type of content viewed. Studies three and four captured information regarding ST context and the content viewed on screens, but did not specify the amounts of each type of content viewed. This research was limited in that it did not consider the different impacts that different ST content might have had on findings. Similarly to the present research, McArthur et al. (2021) identified a gap in the literature

accounting for the content and context of ST data, which would be a worthy area of attention for future research.

It has been suggested that the relevance of content viewed by children on screens may extend beyond whether it is educational vs. recreational. In fact, parents need to be better informed about the richness and variety of both types of content that children may be exposed to. Content should be age-appropriate, encourage active engagement with the social and physical world rather than the passive receiving of information, and encourage individual development; children should also be shielded from harmful content such as violent material or material that could produce fear or anxiety (Biggins et al., 2011). Wainright (2006) proposed quality educational programs that capture children's attention, stimulate active learning, engage children cognitively and maintain their interest. Successful children's programs that enrich their learning include *Blue's Clues* and *Sesame Street* TV series (Common Sense Media, 2021). The effects of ST may depend on the type of content viewed.

With many children constantly accessing and viewing screens, it is important to consider the particular conditions relating to ST that may lead to detrimental outcomes. One concern in the field is that the definition of ST may vary between studies, and some of these methodological issues were brought to light in the systematic review. For example, some studies do not distinguish between active or interactive engagement with screens and passive or sedentary screen use (Tang et al., 2021). A future direction for research may be to consider the effects of not only the amount of time spent on screens, but also the context and content of material viewed. It may be worthwhile to distinguish between recreational and educational content, to consider age and developmentally appropriate material, and to distinguish between active vs. passive viewing, in order to provide a more accurate representation of ST's effects. Therefore, a diary approach method may be useful for reporting on these additional elements of screen use.

Lastly, this research highlighted the importance of the system surrounding the child due to its direct and indirect influence on children's outcomes. As children spend the most time with their parents in their early years, parents are the key target for intervention for this cohort. For children of primary school age, which is when early screen habits begin, clinical trials may be a useful way to determine the effectiveness of parenting programs, particularly those that incorporate a large focus on mental health alongside establishing healthy screen time habits.

General Conclusion

With technology constantly evolving, it is crucial to stay up to date with healthy screen practices and enhance our understanding as new devices emerge. The latest technological revolution has seen children engage with multiple devices in different settings, and at a younger age than ever before. The COVID-19 pandemic has shifted the way screens are utilised, with more children accessing devices for educational purposes, as well as for recreation. This has also been a time when parents have experienced increasing levels of depression, anxiety and stress. Therefore, this research is of a timely nature, in that ST habits have been changing in this environment, and parental mental health has simultaneously been significantly impacted.

Overall, this thesis has contributed to the field in a number of ways. The present research supports the hypotheses that parents form the basis for screen habits in children, and that these habits are learned in early childhood, which have a number of implications for later developmental outcomes. It is essential that ST policy and guidelines involve the whole family and are also tailored to vulnerable populations, particularly parents struggling with poor mental health. Mental health interventions addressing relevant issues of concern for parents of young children, as well as becoming accessible to these "busy" populations may be

of greater benefit, where mobile applications can be fruitful in this area. At a time where children are surrounded by technology, it is all the more essential to teach children to develop positive and healthy habits, and ways to manage their screen time, rather than just limiting their exposure. In order to establish healthy child screen use, we need to consider not only the amount of exposure, but also ST content, and the context and conditions under which it is viewed. These are the areas that require further investigation in the field. Ultimately, the moments of disconnection from our screens can redirect our attention to our children.

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Appendices

Appendix A: Participant Information Sheet

PARTICIPANT INFORMATION SHEET

Parental Characteristics and Screen Time on Early Childhood Development

UTS HREC REF NO. ETH18-2354

WHO IS DOING THE RESEARCH?

My name is Miss Nghi Bui and I am a Doctor of Philosophy (Clinical Psychology) student at UTS. My supervisors are Dr John McAloon and Dr. Josephine Paparo at the UTS Graduate School of Health.

WHAT IS THIS RESEARCH ABOUT?

During childhood, parents have an influential role in a child's development and future outcomes. On top of that, early childhood activities and experiences, such as screen time, may impact a child's development. Screen time has become increasingly prevalent in the lives of children and has become a dominant pastime in early childhood. Children engaging in screen time has also often been a source of conflict in the home. This research would like to further investigate the effects of handheld screens on development, considering the large role it plays in children's lives today.

WHY HAVE I BEEN ASKED?

You have been invited to participate in this study because we are interested in hearing more about your wellbeing, your family, and the role of handheld devices (e.g. iPads, tablets, smartphones) in your home and your child's development. Please only complete this survey if your child is born between 30/07/2013 to 30/09/2014 and engages in handheld device use.

IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate, I will invite you to complete a two-part online survey that is expected to be completed in 2019 and 2020. Each survey will take approximately 30 minutes to complete. You will be re-contacted in 2020 to remind you to complete the second part of the online survey.

The online survey will ask you some questions about your parenting experiences and wellbeing, your child's screen time and their development during school. We also appreciate your efforts in completing the survey and you will be eligible to enter in a draw to win 1 of 4 $100 Coles/Myer Gift Cards at each time-point.

The results of this research will be used in Miss Nghi Bui's thesis for Doctor of Philosophy. The research may also be used for publication in an academic journal or be presented at conferences. All reportable information will be de-identified.

ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some risks/inconvenience. You may be asked potentially sensitive questions about you and your child. While we expect limited risk and distress whilst completing the survey, if you do become distressed recalling you and/or your child's experiences, we will provide information to contact services upon completion or withdrawal from the study.

DO I HAVE TO SAY YES?

Participation in this study is voluntary. It is completely up to you whether or not you decide to take part.

WHAT WILL HAPPEN IF I SAY NO?

If you decide not to participate, it will not affect your relationship with the researchers or the University of Technology Sydney. If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason, by contacting Miss Nghi Bui on the details below.

If you withdraw from the study, your data will be destroyed. However, it may not be possible to withdraw your data from the study results if these have already had your identifying details removed.

CONFIDENTIALITY

By signing the consent form you consent to the research team collecting and using personal information about you for the research project. All this information will be treated confidentially. All participants will be assigned a Unique Participant Identifying Code (UPIC). This code will then be attached to the participant's email stored separately in a password protected file. The UPIC will then be attached to all participant research data and this will be stored without reference to participant identifying information in an independent password protected file. Your information will only be used for the purpose of this research project. Only the nominated researchers will have access to the material provided by participants in this study. This will ensure that data will be kept confidential, both during the collection phase and in the publication of results. The exceptions to confidentiality include any disclosure of risk of harm to yourself or others, including harm to children or if there is a legal requirement. In these circumstances, the researcher will have to break confidentiality.

We plan to publish and use the results in a doctoral thesis, journal article and potentially at a conference.

In any publication, information will be provided in such a way that you cannot be identified.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I or my supervisor can help you with, please feel free to contact us on the details below:

Primary Investigator: Nghi Bui

Email: nghi.h.bui@student.uts.edu.au

UTS Primary Supervisor: Dr. John McAloon

Phone: +61 2 9514 7240, Email: john.mcaloon@uts.edu.au

UTS Secondary Supervisor: Dr. Josephine Paparo

Phone: +61 2 9514 4276, Email: josephine.paparo@uts.edu.au

If you wish to talk to someone about how you feel during or after completion of the survey we encourage you to contact:

- Parentline – 1300 1300 52
- Kids Helpline – 1800 55 1800 (24 hours)
- Lifeline – 11 13 14 (24 hours)
- UTS Psychology Cinic – 9514 7339
- Your local GP or wellbeing team at your child's local school

Additionally, if you are feeling distressed during or after this survey, referral information can be provided. Please consult with your local GP as soon as possible to seek their advice. Alternatively, please do not hesitate to contact one of the researchers listed above should we able to support you in this in any way.

Please screenshot this page for a personal copy of this information sheet.

NOTE:

This study has been approved by the University of Technology Sydney Human Research Ethics Committee [UTS HREC]. If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au], and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

Appendix B: Participant Consent Form

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

CONSENT FORM

PARENTAL CHARACTERISTICS AND SCREEN TIME IN EARLY CHILDHOOD DEVELOPMENT

UTS HREC REF NO. ETH18-2354

I _____ agree to participate in the research project *Parental Characteristics and Screen Time in Early Childhood Development [UTS HREC REF NO. ETH18-2354]* being conducted by Miss Nghi Bui under the supervision of Dr John McAloon and Dr Josephine Paparo at the Graduate School of Health, UTS.

I have read the Participant Information Sheet or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationships with the researchers and the University of Technology Sydney.

I understand that I can screenshot this page for a personal copy of the consent form.

I agree that the research data gathered from this project may be published in a form that:

☐ Does not identify me in any way

☐ May be used for future research purposes

I am aware that I can contact Miss Nghi Bui on the details provided above if I have any concerns about the research.

By saying yes, I agree to give my informed consent to participate in this research.

NOTE:

This study has been approved by the University of Technology Sydney Human Research Ethics Committee [UTS HREC]. If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

Appendix C: Ethics Approval Letters

HREC Approval Granted - ETH18-2354

Research.Ethics@uts.edu.au

Fri 30/11/2018 2:04 PM

To John McAloon <John.McAloon@uts.edu.au>; Nghi Bui <Nghi.H.Bui@student.uts.edu.au>; Research Ethics <research.ethics@uts.edu.au>;

Dear Applicant

Thank you for your response to the Committee's comments for your project titled, "Parental Characteristics and Children's Screen Time - Implications for Developmental Outcomes". The Committee agreed that this application now meets the requirements of the National Statement on Ethical Conduct in Human Research (2007) and has been approved on that basis. You are therefore authorised to commence activities as outlined in your application on the condition that evidence of approval from Principals of participating schools is provided to the HREC prior to commencing the recruitment process.

You are reminded that this letter constitutes ethics approval only. This research project must also be undertaken in accordance with all UTS policies and guidelines including the Research Management Policy (http://www.gsu.uts.edu.au/policies/research-management-policy.html).

Your approval number is UTS HREC REF NO. ETH18-2354.

Approval will be for a period of five (5) years from the date of this correspondence subject to the submission of annual progress reports.

The following standard conditions apply to your approval:

- Your approval number must be included in all participant material and advertisements. Any advertisements on Staff Connect without an approval number will be removed.

- The Principal Investigator will immediately report anything that might warrant review of ethical approval of the project to the Ethics Secretariat (Research.Ethics@uts.edu.au).

- The Principal Investigator will notify the UTS HREC of any event that requires a modification to the protocol or other project documents, and submit any required amendments prior to implementation. Instructions can be found at https://staff.uts.edu.au/topichub/Pages/Researching/Research%20Ethics%20and%20Integrity/Human%20research%20ethics/Post-approval/post-approval.aspx#tab2.

- The Principal Investigator will promptly report adverse events to the Ethics Secretariat (Research.Ethics@uts.edu.au). An adverse event is any event (anticipated or otherwise) that has a negative impact on participants, researchers or the reputation of the University. Adverse events can also include privacy breaches, loss of data and damage to property.

- The Principal Investigator will report to the UTS HREC annually and notify the HREC when the project

- The Principal Investigator will obtain any additional approvals or authorisations as required (e.g. from other ethics committees, collaborating institutions, supporting organisations).

- The Principal Investigator will notify the UTS HREC of his or her inability to continue as Principal Investigator including the name of and contact information for a replacement.

I also refer you to the AVCC guidelines relating to the storage of data, which require that data be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.

You should consider this your official letter of approval. If you require a hardcopy please contact Research.Ethics@uts.edu.au.

If you have any queries about your ethics approval, or require any amendments to your research in the future, please do not hesitate to contact Research.Ethics@uts.edu.au.

Yours sincerely,

Dr Tim Luckett
(Acting) Chairperson
UTS Human Research Ethics Committee
C/- Research & Innovation Office
University of Technology, Sydney
E: Research.Ethics@uts.edu.au

From: Research.Ethics@uts.edu.au
Sent: Thursday, 29 August 2019 3:20 PM
To: Nghi Bui; John McAloon; Research Ethics
Subject: HREC Approval Granted - ETH19-3862

Dear Applicant

UTS HREC REF NO. ETH19-3862

The UTS Human Research Ethics Expedited Review Committee reviewed your amendment application for your project titled, "Parental Characteristics and Children's Screen Time - Implications for Developmental Outcomes", and agreed that the amendments meet the requirements of the NHMRC National Statement on Ethical Conduct In Human Research (2007). I am pleased to inform you that the Committee has approved your request to amend the protocol as follows:

"The addition of a study under the existing scope of the program approval for "Incidental Forgetting and Accidental Remembering - Study 1"I would like to expand my recruitment sample to educational institutions, online media, and social media community groups outside of NSW and ACT to Australia wide."

This amendment is subject to the standard conditions outlined in your original letter of approval.
You are reminded that this letter constitutes ethics approval only. This research project must also be undertaken in accordance with all UTS policies and guidelines including the Research Management Policy (http://www.gsu.uts.edu.au/policies/research-management-policy.html).

You should consider this your official letter of approval. If you require a hardcopy please contact the Research Ethics Officer (Research.Ethics@uts.edu.au).

To access this application, please follow the URLs below:
* if accessing within the UTS network: https://rm.uts.edu.au
* if accessing outside of UTS network: https://vpn.uts.edu.au , and click on " RM6 – Production " after logging in.

If you wish to make any further changes to your research, please contact the Research Ethics Secretariat in the Research and Innovation Office on 02 9514 2478.

In the meantime I take this opportunity to wish you well with the remainder of your research.

Yours sincerely,

A/Prof Beata Bajorek
Chairperson
UTS Human Research Ethics Committee
C/- Research & Innovation Office
University of Technology, Sydney
E: Research.Ethics@uts.edu.au

HREC Approval Granted - ETH20-4899

Research.Ethics@uts.edu.au <Research.Ethics@uts.edu.au>
Tue 26/05/2020 8:06 AM

To: Research Ethics <research.ethics@uts.edu.au>; Nghi Bui <Nghi.H.Bui@student.uts.edu.au>; John McAloon <John.McAloon@uts.edu.au>

1 attachments (176 KB)
Ethics Application.pdf;

Dear Applicant

Re: ETH20-4899 - "Parental Characteristics and Children's Screen Time Implications for Developmental Outcomes"

The UTS Human Research Ethics Expedited Review Committee reviewed your amendment application for your project and agreed that the amendments meet the requirements of the NHMRC National Statement on Ethical Conduct In Human Research (2007). I am pleased to inform you that the Committee has approved your request to amend the protocol as follows:

We would like to include additional parenting scales to the current questionnaire of this study. This includes the: Technology-related Parenting Scale (TPS; Sanders, Parent, Forehand, & Breslend, 2016a) and Parental Perceptions of Technology Scale (PPTS; Sanders & Parent, 2014b). The former is a 8-item scale assessing for the rules and enforcement strategies over child's screen time in the home. Higher scores reflect more behavioral control of child technology use. The reliability across the three samples (ie. young childhood, middle childhood and adolescents) was excellent (α = .87; Sanders, Parent, Forehand, Sullivan, & Jones, 2016c). In addition, previous research has supported the the use of the TPS across child development stages, and supporting initial discriminant and concurrent validity (Sanders et al., 2016a). The latter is a 10-item scale measuring the parental negative beliefs around electronic devices and perceived efficacy in managing devices. It includes two subscales: negative attitudes about technology and perceived parental efficacy. The alpha coefficient for the Negative Attitudes (4 items; M = 9.72, SD = 3.42) and Perceived Parental Efficacy (6 items; M = 20.93, SD = 4.53) subscales across the three samples was .72 and .83, respectively (Sanders et al., 2016c). This scale was developed for this study, and item content was derived from pilot research in a prevention context with parents who expressed concerns about their children's technology use (Sanders et al., 2016c).

This amendment is subject to the standard conditions outlined in your original letter of approval.

You are reminded that this letter constitutes ethics approval only. This research project must also be undertaken in accordance with all UTS policies and guidelines including the Research Management Policy.

You should consider this your official letter of approval. If you require a hardcopy please contact the Ethics Secretariat.

To access this application, please click here, a copy of your application has also been attached to this email.

If you wish to make any further changes to your research, please contact the Research Ethics Secretariat on 02 9514 2478.

In the meantime I take this opportunity to wish you well with the remainder of your research.

Yours sincerely,

A/Prof Beata Bajorek
Chairperson
UTS Human Research Ethics Committee
C/- Research Office
University of Technology Sydney
Research.Ethics@uts.edu.au | Website
PO Box 123 Broadway NSW 2007

UTS HREC Approval - ETH20-5260

Research.Ethics@uts.edu.au <Research.Ethics@uts.edu.au>
Mon 7/09/2020 3:20 PM

To: Research Ethics <research.ethics@uts.edu.au>; John McAloon <John.McAloon@uts.edu.au>; Marilyn Cruickshank <Marilyn.Cruickshank@uts.edu.au>; Nghi Bui <Nghi.H.Bui@student.uts.edu.au>; Jane Maguire <Jane.Maguire@uts.edu.au>

1 attachments (187 KB)
Ethics Application.pdf;

Dear Applicant

Re: ETH20-5260 - "Parental Characteristics and Children's Screen Time - Implications for Developmental Outcomes"

The HREC Expedited Review Committee reviewed your amendment application for your project and agreed that the amendments meet the requirements of the NHMRC National Statement on Ethical Conduct In Human Research (2007). I am pleased to inform you that the Committee has approved your request to amend the protocol as follows:

We would like to add a few short answer follow-up questions to our existing survey for the second wave of data collection regarding the impacts of COVID-19 on screen time. The total time has not changed, the current participant information sheet reads approximately 30 minutes. As shown in the tracked changed copy, compared to the initial wave of data collection, most of the demographic questions have been omitted for the second wave (as this has already been collected). Therefore, this would adjust for the time with the new questions added. Moreover, I am confirming that the amendment consists of the questions being added to the existing line and are line with the original aims and objectives.

This amendment is subject to the standard conditions outlined in your original letter of approval. You are reminded that this letter constitutes ethics approval only. This research project must also be undertaken in accordance with all UTS policies and guidelines including the Research Management Policy.

You should consider this your official letter of approval. If you require a hardcopy please contact the Research Ethics Secretariat.

To access this application, please click here, a copy of your application has also been attached to this application

If you wish to make any further changes to your research, please contact the Research Ethics Secretariat in the Research Office.

In the meantime I take this opportunity to wish you well with the remainder of your research.

Yours sincerely,

Prof Beata Bajorek
Chairperson

UTS Human Research Ethics Committee
C/- Research Office
University of Technology Sydney
T: (02) 9514 2478
Research.Ethics@uts.edu.au | Website
PO Box 123 Broadway NSW 2007

HREC Approval Granted - ETH20-4889

Research.Ethics@uts.edu.au <Research.Ethics@uts.edu.au>
Wed 1/07/2020 7:57 AM

To: Research Ethics <research.ethics@uts.edu.au>; Jane Maguire <Jane.Maguire@uts.edu.au>; Nghi Bui <Nghi.H.Bui@student.uts.edu.au>

1 attachments (279 KB)
Ethics Application.pdf;

Dear Applicant

Re: ETH20-4889 - "The Effects of Child Screen Time on Academic Achievement"

Thank you for your response to the Committee's comments for your project. The Committee agreed that this application now meets the requirements of the National Statement on Ethical Conduct in Human Research (2007) and has been approved on that basis. You are therefore authorised to commence activities as outlined in your application.

You are reminded that this letter constitutes ethics approval only. This research project must also be undertaken in accordance with all UTS policies and guidelines including the Research Management Policy.

Your approval number is UTS HREC REF NO. ETH20-4889.

Approval will be for a period of five (5) years from the date of this correspondence subject to the submission of annual progress reports.

The following standard conditions apply to your approval:

- Your approval number must be included in all participant material and advertisements. Any advertisements on Staff Connect without an approval number will be removed.
- The Principal Investigator will immediately report anything that might warrant review of ethical approval of the project to the Ethics Secretariat (Research.Ethics@uts.edu.au).
- The Principal Investigator will notify the UTS HREC of any event that requires a modification to the protocol or other project documents, and submit any required amendments prior to implementation. Instructions on how to submit an amendment application can be found here.
- The Principal Investigator will promptly report adverse events to the Ethics Secretariat. An adverse event is any event (anticipated or otherwise) that has a negative impact on participants, researchers or the reputation of the University. Adverse events can also include privacy breaches, loss of data and damage to property.
- The Principal Investigator will report to the UTS HREC annually and notify the HREC when the project is completed at all sites. The Principal Investigator will notify the UTS HREC of any plan to extend the duration of the project past the approval period listed above through the progress report.
- The Principal Investigator will obtain any additional approvals or authorisations as required (e.g. from other ethics committees, collaborating institutions, supporting organisations).
- The Principal Investigator will notify the UTS HREC of his or her inability to continue as Principal Investigator including the name of and contact information for a replacement.

This research must be undertaken in compliance with the Australian Code for the Responsible Conduct of Research and National Statement on Ethical Conduct in Human Research.
You should consider this your official letter of approval. If you require a hardcopy please contact the Ethics Secretariat.

Appendix D: Stakeholder Approval Letters

NSW GOVERNMENT Education Public Schools

Miss Nghi Bui

DOC19/318729
SERAP 2018781

Dear Miss Bui

I refer to your application to conduct a research project in NSW government schools entitled *Parental Characteristics and Screen Time on Early Childhood Development*. I am pleased to inform you that your application has been approved.

You may contact principals of the nominated schools to seek their participation. **You should include a copy of this letter with the documents you send to principals.**

This approval will remain valid until 1 May 2020.

The following researchers or research assistants have fulfilled the Working with Children screening requirements to interact with or observe children for the purposes of this research for the period indicated:

Researcher name	WWCC	WWCC expires
Nghi Bui	WWC1285914V	07-Mar-2022
Josephine Paparo	WWC0324351E	22-Mar-2019
Thomas (John) McAloon)	WWC0154636E	08-Nov-2023

I draw your attention to the following requirements for all researchers in NSW government schools:

- The privacy of participants is to be protected as per the NSW Privacy and Personal Information Protection Act 1998.
- School principals have the right to withdraw the school from the study at any time. The approval of the principal for the specific method of gathering information must also be sought.
- The privacy of the school and the students is to be protected.
- The participation of teachers and students must be voluntary and must be at the school's convenience.
- Any proposal to publish the outcomes of the study should be discussed with the research approvals officer before publication proceeds.
- All conditions attached to the approval must be complied with.

When your study is completed please email your report to: serap@det.nsw.edu.au.
You may also be asked to present on the findings of your research.

I wish you every success with your research.

Yours sincerely

Rah Kirsten
A/Manager, Research
1 May 2019

School Policy and Information Management
NSW Department of Education
Level 1, 1 Oxford Street, Darlinghurst NSW 2010 – Locked Bag 53, Darlinghurst NSW 1300
Telephone: 02 9244 5060 – Email: serap@det.nsw.edu.au

Sydney Catholic Schools
INSPIRING SPIRITS AND MINDS

29 March 2019

Dear Nghi Bui

Thank you for the submission of your application to conduct research in Archdiocesan Catholic Schools under the jurisdiction of the Sydney Catholic Schools.

Approval is given by Sydney Catholic Schools to conduct this study. This approval is granted subject to full compliance with NSW Child Protection and Commonwealth Privacy Act legislation.

It is the prerogative of any Principal or staff member whom you might approach to decline your invitation to be involved in this study or to withdraw from involvement at any time.

Any study involving the participation of students will require written, informed consent by parents/guardians.

Permission is given for you to approach the Principals of the schools nominated, listed below, requesting participants for your study: **Parental Characteristics and Screen Time on Early Childhood Development**

All Hallows Catholic Primary School FIVE DOCK 1306	Blessed Sacrament Catholic Primary School CLIFTON GARDENS 1322
Holy Cross Catholic Primary School WOOLLAHRA 1388	McAuley Catholic Primary School ROSE BAY 1417
Our Lady of Fatima Catholic Primary School CARINGBAH 1482	Our Lady of Mt Carmel Catholic Primary School Mount Pritchard
St Aloysius Catholic Primary School CRONULLA 1564	St Catherine Labouré Catholic Primary School GYMEA 1613
St Declan's Catholic Primary School PENSHURST 1631	St Francis Xavier's Catholic Primary School ARNCLIFFE 1650
St James Catholic Primary School FOREST LODGE 1665	St John's Catholic Primary School AUBURN 1677
St Joseph's Catholic Primary School BELMORE 1746	St Luke's Catholic Primary School REVESBY 1815
St Mary - St Joseph Catholic Primary School MAROUBRA 14282	St Mel's Catholic Primary School CAMPSIE 1876
St Patrick's Catholic Primary School SUTHERLAND 1908	St Pius' Catholic Primary School ENMORE 1952

St Therese Catholic Primary School MASCOT 1970	St Thomas More's Catholic School BRIGHTON-LE-SANDS 1980
Villa Maria Catholic Primary School HUNTERS HILL 2036	

COMMONWEALTH PRIVACY ACT

The privacy of the school and that of any school personnel or students involved in your study must, of course, be preserved at all times and comply with requirements under the Commonwealth Privacy Amendment (Private Sector) Act 2000. In complying with this legislation, Sydney Catholic Schools has decided that individual research participants should not be identified in the report.

FURTHER REQUIREMENTS

Data collectors with contact with students much complete the SCS Child Safe Communities (CSC) Contractors and Volunteers Working with Children (WWC) Accreditation Process (WWC Accreditation Process), which involves being inducted in child protection, reading and understanding the obligations and procedures under the relevant child protection legislation and SCS policies, as well as providing their Working With Children Check (WWCC) clearance number for verification by SCS. Please select the nature of your engagement (i.e. contractor or volunteer) to begin the WWC Accreditation Process. See this Link for details. The approval letter from this CSC must accompany the research approval letter.
It is a condition of approval that when your research has been completed you will forward a summary report of the findings and/or recommendations to this office as soon as results are to hand.
All correspondence relating to this Research should note the following Reference Number: **201841.**

You are required to have read through the Volunteer Resource kit here

Please download a copy of this form and take with you to each school who has agreed to participate in the Research

Please contact me at this office if there is any further information you require. I wish you well in this undertaking and look forward to learning about your findings.

Yours sincerely,

Anne Addicoat

On behalf of: **Teaching and Learning Directorate**
Email: research.centre@syd.catholic.edu.au

Anne Addicoat
Sydney Catholic Schools
Research Centre
38 Renwick Street | PO Box 217 | Leichhardt NSW 2040
t: (02) 9568 8152 | f: 9568 8470
Web | 'About Catholic Schools'

Catholic Schools Office
DIOCESE OF MAITLAND-NEWCASTLE

Director's Office
Brid Corrigan
STRATEGIC PROGRAM ADVISOR
P 4979 1207 F 4979 1208
E brid.corrigan@mn.catholic.edu.au

6 March, 2019.

Ms Nghi Bui
Graduate School of Health
UTS
University of Technology Sydney.

Dear Nghi,

Thank you for your application to conduct research in the Diocese of Maitland-Newcastle. Approval is given for the research project 'Parental Characteristics and Screen Time on Early Childhood Development' within the diocese. Please note the following points in relation to research requests:

- It is the school principal, who gives final permission for research to be carried out in their school.
- The privacy of participants is to be observed in reporting and must comply with the requirements of the Commonwealth Privacy Amendment (Private Sector) Act 2000.
- There should be some feedback to schools and a copy of the findings of the research forwarded to this office.
- This letter of approval should accompany any approach to schools.

The following researchers or research assistants have fulfilled the Working with Children screening requirements to interact with or observe children for the purposes of this research within the Diocese for the period indicated.

Researcher name	Date of Birth	WWCC number	WWCC expiration date
Hoang-Nghi BUI	21/06/1994	WWC1285914E	12-3-24
Thomas MCALOON	07/08/1963	WWC0154636E	8-11-23
Giuseppina KEARNEY (Josephine Paparo)	20/02/1986	WWC0324351E	22-3-24

I look forward to the results of this study and wish you the best over the coming months. If you require any further assistance or wish to discuss any aspect of this research in our diocese, please do not hesitate to contact me.

Yours sincerely,

Brid Corrigan
STRATEGIC PROGRAMS ADVISOR

ADA Dataverse: You have been granted access to dataset: "Growing Up in Australia: Longitudinal Study of Australian Children (LSAC) Release 7.2 (Waves 1-7)>"

ada@anu.edu.au <ada@anu.edu.au>

Fri 17/04/2020 3:31 PM

To: Nghi Bui <Nghi.H.Bui@student.uts.edu.au>

Hello,

You recently applied for access to controlled access files in dataset: Growing Up in Australia: Longitudinal Study of Australian Children (LSAC) Release 7.2 (Waves 1-7). We are pleased to advise that your application for access has been approved.

Your obligations as an Authorised Data User are contained in the Terms and Conditions of Use.

You can now view and download files from the dataset at this link: https://dataverse.ada.edu.au/dataset.xhtml?persistentId=doi:10.26193/F2YRL5.

(Please note that you will need to login to Dataverse to see your updated access, and to download controlled access files.)

If you have any queries in relation to the data please refer to the supporting documentation for Growing Up in Australia: Longitudinal Study of Australian Children (LSAC) Release 7.2 (Waves 1-7), or click on the email icon from anywhere in Dataverse to submit a query.

Thank you,
The Australian Data Archive
on behalf of the data owner(s): Department of Social Services (Australian Government); Australian Institute of Family Studies (Australian Government); Australian Bureau of Statistics (Australian Government).

Parental Characteristics and Screen Time on Early Childhood Development

Gabby Holden <Gabby.Holden@ku.com.au>

Fri 7/06/2019 4:25 PM

To: Nghi Bui <Nghi.H.Bui@student.uts.edu.au>

Dear Nghi,

I am pleased to advise that your application to conduct research in KU services has been approved.

To assist in recruiting participants for your study, we will circulate your flyer to KU services to distribute to eligible families within the service.

I do not appear to have a copy of the flyer, so can you please resend to my attention and we will include it in our next Bulletin for services.

If you have any questions, please don't hesitate to contact me.

Regards

Gabby Holden
Manager Policy and Research ECE
KU Children's Services
M 0434 168 395
www.ku.com.au

KU respectfully acknowledges the traditional owners of the many lands on which our services are delivered. The contribution by Aboriginal and Torres Strait Islander people to the education of young children existed long before our story began.

Appendix E: Additional Results and Tables

Supplementary Table 1: Search terms for databases

Category	Search Terms
Family	parent* OR caregiver* OR mother OR father OR dad OR mum OR mom OR child* OR “early childhood”; AND
Screen	"screen time" OR "screen viewing time" OR "screen use" OR "screen-time" OR "screen-viewing" OR "screen-use" OR iPad* OR tablet* OR smartphone* OR "smart phone*" OR smart-phone OR "handheld device*" OR "electronic device*" OR "handheld device*" OR “portable device*” OR “mobile device*” or “mobile phone” OR “touchscreen*” OR television* OR TV* OR computer* OR PC* OR “tech* device”; AND
Development	development* OR trajectory OR behavio* OR emotion* OR social* OR "social* development" OR "socio* development" OR “social predictor” OR “socio* predictor” OR "behavio* development" OR “behavio* predictor” OR "emotional development" OR “emotional predictor” OR “behavio* problem*” OR “social* problem*” OR “socioemot* problem*” OR “emot* problem*” OR “internali* problem*” OR “externali* problem*” OR mental* OR psychological* OR “stress level*” OR “perceived stress level*” OR stress* OR depressi* OR anx* OR distress*

Supplementary Table 2: Path coefficients for associations between parental mental health measures, screen time (hours/day), internalising and externalising problems in children, and covariates

Variable	b(SE)	*p* value
Parent Phone Daily Usage ON		
Anxiety	.03(.01)	.00**
Parent Age	-.04(.01)	.00**
Education	-.21(.10)	.04*
Household Income	.05(.06)	.40
Parent Tablet Daily Usage ON		
Anxiety	.01(.01)	.02*
Parent Age	-.02(.01)	.01*
Education	-.17(.70)	.02*
Household Income	-.04(.04)	.32
Child Phone Daily Usage ON		
Anxiety	.00(.00)	.39
Parent Age	-.02(.01)	.00**
Education	-.03(.05)	.60
Household Income	-.03(.03)	.35
Child Tablet Daily Usage ON		
Anxiety	.02(.01)	.00**
Parent Age	-.01(01)	.53
Education	.04(.07)	.61
Household Income	.05(.04)	.22
Externalising Problems ON		
Anxiety	.16(.07)	.04*
Parent Phone Daily Usage	.48(.55)	.39
Parent Tablet Daily Usage	-.76(.88)	.39
Child Phone Daily Usage	1.86(1.22)	.13
Child Tablet Daily Usage	-.66(.89)	.46
Parent Age	-.08(.12)	.51
Education	.56(.82)	.50
Household Income	-.40(.50)	.43
Internalising Problems ON		
Anxiety	.11(.07)	.13
Parent Phone Daily Usage	-.02(.54)	.97

Variable	b(SE)	*p* value
Parent Tablet Daily Usage	-.60(.85)	.48
Child Phone Daily Usage	1.38(1.19)	.25
Child Tablet Daily Usage	.06(.87)	.95
Parent Age	-.12(.11)	.28
Education	-.79(.80)	.32
Household Income	-.52(.49)	.29
Parent Tablet Daily Usage ON		
Depression	.01(.01)	.31
Parent Age	-.03(.01)	.01*
Education	-.17(.07)	.02*
Household Income	-.05(.04)	.21
Child Phone Daily Usage ON		
Depression	-.00(.01)	.81
Parent Age	-.02(.01)	.00**
Education	-.03(.05)	.59
Household Income	-.04(.03)	.26
Child Tablet Daily Usage ON		
Depression	.02(.01)	.08
Parent Age	-.01(.01)	.54
Education	.03(.07)	.69
Household Income	.04(.04)	.34
Externalising Problems ON		
Depression	.32(.13)	.02*
Parent Phone Daily Usage	.48(.55)	.39
Parent Tablet Daily Usage	-.66(.87)	.45
Child Phone Daily Usage	1.96(1.22)	.11
Child Tablet Daily Usage	-.62(.88)	.48
Parent Age	-.05(.12)	.66
Education	.49(.82)	.55
Household Income	-.41(.49)	.41
Internalising Problems ON		
Depression	.26(.13)	.04*
Parent Phone Daily Usage	-.04(.54)	.95
Parent Tablet Daily Usage	-.54(.84)	.52
Child Phone Daily Usage	1.48(1.19)	.21
Child Tablet Daily Usage	.06(.86)	.94
Parent Age	-.10(.11)	.37
Education	-.85(.79)	.29
Household Income	-.50(.48)	.30
Parent Phone Daily Usage ON		
Stress	.05(.02)	.00**
Parent Age	-.05(.01)	.00**
Education	.24(.01)	.02*
Household Income	.06(.10)	.47
Parent Tablet Daily Usage ON		
Stress	.03(.01)	.03
Parent Age	-.03(.01)	.01**
Education	-.18(.07)	.01*
Household Income	-.05(.04)	.29
Child Phone Daily Usage ON		
Stress	.01(.01)	.14
Parent Age	-.02(.01)	.00**
Education	-.03(.05)	.52
Household Income	-.03(.03)	.40
Child Tablet Daily Usage ON		
Stress	.02(.01)	.18
Parent Age	-.01(.01)	.43
Education	.03(.07)	.72
Household Income	.04(.04)	.36

Variable	b(SE)	*p* value
Externalising Problems ON		
Stress	.47(.13)	.00**
Parent Phone Daily Usage	.35(.54)	.52
Parent Tablet Daily Usage	-.86(.86)	.32
Child Phone Daily Usage	1.54(1.19)	.20
Child Tablet Daily Usage	-.39(.86)	.65
Parent Age	-.09(11)	.44
Education	.28(.81)	.73
Household Income	-.33(.49)	.50
Internalising Problems ON		
Stress	.20(.13)	.12
Parent Phone Daily Usage	-.02(.54)	.97
Parent Tablet Daily Usage	-.59(.85)	.49
Child Phone Daily Usage	1.19(1.18)	.32
Child Tablet Daily Usage	.25(.86)	.77
Parent Age	-.13(.11)	.25
Education	-.90(.80)	.26
Household Income	-.54(.48)	.26

*p < 0.05 ** p < 0.01

Supplementary Table 3: Results from Linear Regression with Child Screen Time as the Dependent Variable

Variable	B	SE	t	p
Child Gender	-.01	.29	-.03	.97
Parent Age	-.03	.03	-0.92	.41
Employed vs. Unemployed	-.03	.36	-.08	.94
Currently Married vs Unmarried	.07	.37	.18	.86
Parent Education Level (Completed university-level education)*				
Parent Education Level (Completed Y12 Cert)	.20	.45	.45	.65
Parent Education Level (Completed Diploma/TAFE)	.12	.38	.33	.74
Annual Household Income (<$100,000)*				
Annual Household Income ($100,000-$150,000)	.02	.37	.05	.96
Annual Household Income ($150,000-$200,000)	-.23	.39	-.58	.56
Annual Household Income (>$200,000)	-.25	.38	-.66	.51
Parental Screen Time	.05	.09	.58	.57
Parental Limit Setting for Technology	-.09	.05	-1.68	.10
Parental Negative Attitudes towards Technology	-.05	.05	-1.08	.29
Parental Perceived Efficacy towards Technology	.03	.04	.80	.43
Parental Anxiety	-.02	.03	-.49	.62
Parental Depression	0.02	.06	.38	.71
Parental Stress	.01	.04	.28	.78