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**Is Digital Technology Use Associated with Child Well-Being?**  
**A Test of the Goldilocks Hypothesis with Children in Aotearoa New Zealand**

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## Abstract

The rise of electronic media has driven concerns that digital device-use may affect the well-being of children. However, research with children is limited with largely mixed results. The present project tested the Digital Goldilocks Hypothesis, and therefore assessed whether there is a U-shaped association between digital technology-use and psychological health problems. The parents of 703 New Zealand children, aged six- to eleven-years old, answered questions about the typical time their child spent watching videos and playing digital games on weekends and weekdays. Child psychological well-being was measured using parent and teacher reports on the Behaviour Assessment System for Children, Second Edition (BASC-2). Inconsistent with the Digital Goldilocks Hypothesis we found no evidence of reliable curvilinear associations. However, small, positive, linear associations were found between video engagement and three areas of parent-reported psychological well-being: internalising problems, externalising problems, and adaptive skills. All measured associations between digital game play and child psychological well-being were non-significant, except for two associations between weekend digital game play and the adaptive and internalising composites. Results suggest that passive digital media use may have a larger impact on well-being than active digital media use for children. In addition, results suggest that linear, rather than curvilinear, associations may best explain the link between well-being and video engagement for primary school aged children. Future research is required to explore replicability and understand the causal nature of the data.

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## **Chapter One: Children and Technology**

Digital technology is now a dominant feature of children's lives. Over the past century, advances in technology have increased the ubiquity and utility of digital devices in many children's experiences (Graafland, 2018; Gottschalk, 2019). Children often use tablets, mobile phones, and television sets before they learn to walk and talk (Holloway et al., 2013; Prieur, 2020). In industrialised countries, nearly all children live in technology-rich homes and engage with multiple digital devices every day (Singer & Singer, 2012; New Zealand on Air, 2020). Moreover, children born over the last few decades have been defined by their abundant technology use, with the terms, "Digital Natives" and the "Net Generation" (Prensky, 2001; Selwyn, 2009; Tapscott, 1999). Overall, today's children are growing up and developing in a digitally saturated world (Graafland, 2018). This thesis will investigate the impact of this prominent digital technology use on children's psychological well-being.

### **Child Screen Time**

A considerable amount of literature has been published on child digital exposure levels. These studies have found that children spend a substantial amount of time using digital technology internationally (LeBlanc et al., 2015; Sigman, 2015; Thomas et al., 2020). For example, in the United States of America (USA), Rideout et al. (2010) investigated child digital media engagement in a nationally representative study. In this study, 2,002 eight- to 18-year-olds, were asked about their digital device use from the previous day. Rideout et al. (2010) found American children spent, on average, 7.6 hours using digital devices each day. Specifically, children reported, 4.5 hours watching television, 1.5 hours using the computer, 1.2 hours playing video games and 0.4 hours watching movies, on average. Based on their

data, the authors concluded that American children spend a significant proportion of their time engaged with digital devices daily.

In the United Kingdom, the national regulator of television, internet, and mobile services, OfCom, also investigated child screen time patterns (OfCom, 2019). To measure UK children's screen time, 1,430 parents and their eight- to -fifteen-year-olds, were interviewed about their digital media engagement. In this study, THE screen time of children aged five- to seven-years was parent-reported, while screen time for children aged 12-15-years was child-reported. OfCom (2019) found UK children spent 6.6 hours using technology in the week and 10.1 hours in the weekend. On a weekday, OfCom (2019) found children spent, on average, 1.9 hours online, 1.3 hours playing games on any device, 1.6 hours watching television, and 1.8 hours using a mobile phone. These results suggest that in the UK children also devote much of their time to digital media use.

Consistent with research in the USA and UK, research in Aotearoa/New Zealand indicates that New Zealand children's screen time is sizeable. For example, New Zealand on Air and the Broadcasting Standards Authority (2020) recently investigated media use in a nationally representative sample of children aged six- to fourteen-years. To measure media consumption, 1,112 children and their parents or caregivers were interviewed online or face-to-face. The authors found that children spent, on average, 4.87 hours watching television content and 3.38 hours engaged with online media each day. In sum, these values suggest that New Zealand children's total screen time may be over eight hours each day. From these data, it can be concluded that New Zealand children are also growing up in media-rich worlds.

Taken together, the research described thus far indicates that, in many western industrialised countries, children are using digital devices for a significant proportion of their daily lives (Christakis et al., 2004; New Zealand on Air, 2020; OfCom, 2019; Rideout et al., 2010; Stats New Zealand, 2010; Thomas et al., 2020). Further research supports these conclusions by showing that digital media engagement is one of the most common activities for children (Gracia et al., 2020). These studies find that children spend more time in screen-based activities than in social, active, or educational activities (Gracia et al., 2021). However, authors of the previously discussed studies also suggest that their total reported screen time values may be inflated by measurement artifacts, such as the phenomenon of digital media multitasking. Media multitasking has been defined as the use of more than one digital media device simultaneously (Rideout et al., 2010). For example, playing a game on a mobile phone while also watching television. In the previously discussed study, Rideout et al., (2010) calculated their final media use values by reducing media exposure by the proportion of time during which media-multitasking occurred. Nonetheless, irrespective of whether and how multitasking is considered in the measurement of media exposure, the research described so far still indicates that screen time makes up a major portion of children's daily lives.

### **Increasing Screen Time**

While the above research demonstrates that children's screen time is already considerable, studies also show child screen time is increasing over time (Hofferth, 2010; Smahel et al., 2020). For example, Rideout et al.'s (2010) previously described study was part of a series of studies which investigated child screen time in 1999, 2004 and 2009. The authors found that from 1999 to 2009, child media use increased for every type of screen-

based media measured. From 2004 to 2009, this rise included an increase of 0.4 hours a day for video games, 0.45 hours a day for computers, 0.63 hours for television content, and more than one hour increase for total screen time. The amount of time spent media multitasking also increased by approximately two hours, from 1.17 hours in 2004, to 3.12 hours in 2009. Rideout et al. (2010) concluded that there had been a large increase in child screen time from 1999 to 2009.

In the United Kingdom, Mullan (2018) also investigated child digital technology use patterns over time. In this study, time use surveys were collected from eight- to 18-year-olds in 2000 and in 2015. Similar to the US results reported by Rideout et al. (2010), Mullan (2018) found that UK children's total screen use increased by almost two hours over the duration of the study, from 2.98 hours, in 2000 to 4.75 hours, in 2015. For each device, this included increases of 0.25 hours a day for computer use, 0.39 hours for videogame play, and 0.17 hours for watching TV as a secondary activity. However, time spent watching TV as a primary activity was found to decrease by 0.42 hours over this time. Mullan (2018) concluded that the total time children spent engaged with screen-based devices increased significantly between 2000 and 2015. This finding is also supported by other studies showing that total screen-based technology use by children continues to increase in the United Kingdom in recent years (OfCom, 2019).

Studies of children in Aotearoa/New Zealand are consistent with digital technology use trends reported overseas. In 2015 and 2020, New Zealand on Air and the Broadcasting Standards Authority in New Zealand commissioned a series of studies, investigating media use by New Zealand children. Compared to the 2015 study, the previously described 2020 study found considerable increases in parental reports of video, television, and movie

streaming service use by children. One of the key findings of the 2020 study was that use of screen-based technology by children had seen high levels of growth over the previous five years. In summary, the studies presented so far suggest that screen-based technology use by children is increasing worldwide.

### **Screen time for young children**

Alongside children's rising screen time, digital device use is also beginning at very early ages. Most infants and toddlers use some form of digital media every day, often for considerable time, similar to the amount of time spent in social play (Rideout & Hamel, 2006; Tandon et al., 2011). In the USA, most children, aged between 6 months and 6 years, know how to turn on the TV by themselves (74%), change the television channels (58%), and one third of them have a television in their bedroom (Common Sense Media, 2017; Rideout and Hamel, 2006). Increasingly, digital media content is being designed specifically for young children (Wartella & Robb, 2008). There are now thousands of programmes and applications available which are designed specifically for infants and toddlers (Garrison & Christakis, 2005; Goodrich, Pempek & Calvert, 2009).

In the USA, Common Sense Media (2017) investigated the use of digital devices by young children over time. Common Sense Media (2017) conducted a series of nationally representative surveys in 2011, 2013, and 2017, of children in the USA, aged zero to eight years old. The authors found that in 2017, parents reported young children spent 2.27 hours each day engaged with digital media. Specifically, 0.97 hours watching television on a TV set, 0.7 hours watching DVDS, videos, and TV on other devices, 0.42 hours playing digital media games, and 0.18 hours engaged with other digital activities, including educational tasks. On the basis of their data, Common Sense Media (2017) concluded that children begin engaging

with digital media at a very young age and consistently spend many hours a day engaged with screen-based devices.

Although the literature is limited, technology use by young children in Aotearoa/New Zealand appears to be following global trends. For example, New Zealand on Air and Broadcasting Standards Authority (2015) found that almost all pre-schoolers (96%) engage with digital media. Substantial digital media use was especially noted for time spent watching TV (88%) and DVDs (70%). Most pre-schoolers use the internet (58%), including 43% of two-year-olds and 71% of five-year-olds (New Zealand on Air and Broadcasting Standards Authority, 2015). The Ministry of Health (2017) has also collected screen time data for children two- to 14-years-old, every year from 2011 to 2017, by asking parents if their child usually watched television or screens for two or more hours a day. In 2017, 32% of children were found to watch two or more hours of television each day, while 83% of children usually watched screen devices, for two or more hours per day. The findings from these studies suggest that screen time for young children in Aotearoa/New Zealand is also substantial.

In summary, over the last few decades, technology use has evolved to play a major role in children's daily lives. Given the dramatic use of digital media by children of all ages, it is important to investigate the possible impacts of this exposure on children's health and well-being. This thesis will investigate the associations between screen time and psychological outcomes for primary school children.

## **Demographics**

Previous research has established associations between digital media engagement and a variety of sociodemographic factors in children. Associated factors include age, gender,

ethnicity, and socioeconomic status. The following subsections will discuss the links between child digital device use and each of these demographic characteristics.

### ***Age***

Age is associated with screen time for primary school aged children. Most studies indicate that children spend more time interacting with all digital devices as they grow older (Anderson et al., 2008; Duch et al., 2013; Huston et al., 1999; Mullan, 2018; Ribner & McHarg, 2021; Twenge & Campbell, 2018). In Aotearoa/New Zealand, studies also suggest that older children spend more time using screen-based devices than younger children (Census At School NZ, 2005; New Zealand on Air, 2020). For example, the Ministry of Health (2006) found that the prevalence of watching two or more hours of television a day was significantly greater for non-Māori children aged 10-14-years than for non-Māori children aged 5-9-years. However, ethnicity appears to moderate these trends, because no significant differences by age group were found for Māori children.

### ***Gender***

For total screen time, some studies have found boys typically spend more time using digital devices than girls overall (Gracia et al., 2021; O'Brien et al., 2021), however other studies have not found gender associations for total screen time (Duch, Fisher, Ensari, & Harrington, 2013; Thomas et. al., 2020; Wright et. al., 2001). For specific devices, internationally and in Aotearoa/New Zealand, boys and girls have been reported to watch comparable amounts of television (Ministry of Health, 2017; Mullan, 2018; Thomas et al., 2020; WHO, 2000). Many studies have found that boys spend more time playing video games than girls (Funk et al., 2000; Hofferth, 2010; Kubey & Larson, 1990; Leatherdale & Ahmed, 2011; Mullan, 2018; Przybylski & Weinstein, 2017; Roberts, 1999; Roberts et al.,

2005; Wright et al., 2001). Some studies also suggest that boys spend more time in general on the computer (Graafland, 2018; Livingstone & Helsper, 2007; Thomas et al., 2020) and most studies find that boys spend more time playing games on computers than girls (Funk, Germann, & Buchman, 2000; Mullan, 2018; Wiecha et al., 2001). On the other hand, studies indicate that girls spend more time on computers while engaged in communication activities, for example, sending emails and using social media (Hofferth, 2010; Leatherdale & Ahmed, 2011).

### ***Ethnicity***

Research reports that belonging to a minority ethnic group is typically associated with greater screen time (Roberts et al., 2005). In the USA, African American children spend more time engaged with digital devices than European American children (Bickham, et al., 2003; Huhman et al., 2012; Roberts & Foehr, 2008; Roberts et al., 2005). In the UK, Hispanic and Black children's screen time is greater than White British children's screen time (Duch et al., 2013; OfCom, 2019). In Aotearoa/New Zealand, Māori ethnicity has been associated with more screen time than New Zealand European ethnicity (Stewart et al., 2019). Several reports have found that Māori children are significantly more likely to engage with digital devices for longer durations each day compared with non-Māori children (Ministry of Health, 2006; New Zealand on Air and Broadcasting Standards Authority, 2020; Stewart et al., 2019).

### ***Socioeconomic Status***

The time children spend using digital devices has been consistently related to their socioeconomic status. Existing research shows that, in general, greater digital media consumption is associated with lower socioeconomic status (Common Sense Media, 2017;

Roberts & Foehr, 2008; Scantlin, 2008; Singer & Singer, 2012;). In the USA, studies have reported that children from lower socioeconomic homes spend almost two hours more using digital devices per day than children from higher socioeconomic homes (Common Sense Media, 2017). Consistent with overseas literature, in Aotearoa/New Zealand, children living in low socioeconomic areas are significantly more likely to watch television than those living in high socioeconomic areas (Ministry of Health, 2006; Stewart et al., 2019). In contrast, international and local studies also suggest that the 'digital divide' persists, where children in households with lower socioeconomic status generally have reduced access to digital devices (Cleary et al., 2006; Livingstone & Helsper, 2007; Roberts et. al., 2005; Statistics New Zealand, 2010; Weatherall & Ramsay, 2006).

### **Historical Media Concerns**

Throughout history, society has been concerned about the possible impacts of media exposure (Briggs & Burke, 2009; Roberts, 1999). The introduction of each new media form has been met with optimism and scepticism. The possible psychological impacts of media have repeatedly caused anxiety and debate throughout history. These debates have become particularly heated when focused on child well-being (Livingstone, 2002). However, several authors have highlighted that with the introduction of each new media form society forgets about previous media 'moral-panics' and becomes more accepting of the preceding media forms, while focusing on the new one (Livingstone, 2002). It is important to be aware of these repeated digital technology 'moral panics' to ensure current research in this field is not overly influenced by these historical trends.

Concerns about children's use of media can be found as far back as the Classical Era. In 375BCE, Plato argued for specific media, such as certain music and stories, to be banned

because of their corrupting influence on young people (Fieser, 2021; Plato, 375BCE, as cited in Roberts, 1999). These concerns have been echoed in contemporary times, when the early 1900s invention of movies, prompted fears films would increase children's immorality and aggression, and negatively affect their education (Flory, 1968; Littner, 1976). These concerns motivated women's groups in the USA to organise weekend movie screenings for children, which were designed to only show films with child appropriate content (Wartella & Robb, 2008). To counter these worries, supporters of movies, including the film industry, spent the early history of films trying to prove the educational benefits and positive effects of movies on young people (Bair, 1938; Davidson, 1954; Flory, 1968; Munsey, 1964).

Parallel to the introduction of movies, the 1920s launch of radio, also sparked controversy. The invention of radio was perceived as an incredible technological advance (Adorno, 1945). However, cynics feared that listening to the radio would displace reading and educational activities for children. Fears were also reported that the radio would prevent its audience from interacting with one another and therefore promote social isolation (Woodford, 1929). Similarly, the widespread popularisation of television, in the 1950s, produced the concern that home television sets would promote social isolation and diminish family functioning (Coffin, 1955; Maccoby, 1951; Murray & Nayman, 1971; Unicef, 2017; Wartella & Rob, 2008). In addition, there was great attention given to the psychological dangers of television viewing by children. Early research investigated if television was impairing children's social contact and their relationships (Maccoby, 1951).

The introduction of computers, in the late 1970s, and the internet, in the 1990s, also provoked concern that these digital inventions would negatively affect relationships, family functioning, and psychological well-being (Abt, 1980; Kraut et al., 1998). Specifically, people

feared that the internet would promote social isolation, because digital social interaction would be less genuine (Stoll, 1995; Turkle, 1996). In the 2000s, society's concern shifted to the possible impacts of videogames. Videogames became popular from the mid-1980s (Calvert, 2015; Singer & Singer, 2012). For videogames, society was primarily concerned about the effects of videogame violence, sexuality, and the lack of educational content (Calvert, 2015). Early research addressed fears that videogames may produce aggression, antisocial behaviour, and reduce empathy (Dill & Dill, 1998; Dominick, 1984). Many early games were perceived to promote violent themes, including "Pac Man" where players "eat" monsters and try to avoid being eaten, and "Space Invaders," which involves the players targeting invading aliens.

In summary, over the last century, the introduction of each new media form has been met with concern and optimism. Moreover, many of the societal fears about media have been repeated over time. Therefore, while it is important to understand and investigate the effects of media on human psychology, it is also important for society and research to be mindful of these ongoing moral panics and fears.

### **Current Media Attitudes**

Today, concerns about the effects of digital media persist. Debate about the psychological impacts of digital devices on children remains a constant part of societal discussion, frequently expressed by academic, policy, and media groups. Recent popular media articles warn that the "Facebook and MySpace generation 'cannot form relationships'" (Smith, 2008), "Is the Internet hurting children?" (Clinton & Steyer, 2012) and "Here's why the Internet has made us lonelier than ever" (Morin, 2018). Meanwhile, in the academic field, the American Psychiatric Association (2013) is considering the addition of

Internet Gaming Disorder (IGD) to the Diagnostic and Statistical Manual of Mental Disorders, which has produced considerable debate (Van Rooji et al., 2018). These routinely voiced concerns in academic and media fields are paralleled in parent communities.

The results from several studies indicate parents worry about the possible negative impacts of media on their child (Lampard et al., 2013, Padilla-Walker, 2006). For example, in a study from the UK, Nwankwo et al. (2019) investigated parental perceptions of children's screen time. This study used data from 140 questionnaires and ten semi-structured interviews from UK parents of children aged five- to 16- years. The authors found that most parents were concerned that their children were spending excessive time using digital devices (84%). Most parents also reported that they felt a lack of control in relation to their children's screen time (80%), with many parents reporting that the major motivator of their children's screen time was addiction (23%). Furthermore, the authors found a significant association between the number of hours children use devices for at the weekends and holidays and the level of concern reported by their parents. Nwankwo et al. (2019) concluded that parents are significantly concerned about their children's digital media engagement.

In Aotearoa/New Zealand, Dorey et al. (2010) also investigated parental perceptions of child screen time. In this study, focus groups with 40 parents of children, aged eight- to 13- years old, were conducted. Focus groups consisted of Māori, Pacific, and non-Māori non-Pacific parents. Qualitative data analysis found that parents generally described digital media as playing a dominant role in their children's lives and were concerned about the amount of time their children engaged with digital media. On the other hand, many parents also appreciated being able to use television as a 'babysitter' to assist with childcare. Dorey

et al. (2010) concluded that parents living in Aotearoa/New Zealand are concerned about their children's total screen time and generally wanted to reduce their children's digital media engagement.

Due to the widespread concern about child digital media consumption held by parents, caregivers, and academics, many organisations have recommended that limits be placed on children's screen time. For example, The World Health Organisation (WHO) recommends that one-year-olds do not spend any time in sedentary screen activities. For children aged two- to five- years, the WHO recommends that screen time should be no more than one hour each day (World Health Organisation, 2019). Even for older children and adolescents, the WHO continues to recommend limiting the amount of time spent in leisure screen time. Similarly, the New Zealand Ministry of Health (2021) recommends no digital device use for children under two-years-old and less than one hour a day for children aged between two- and five-years-old. In addition, the New Zealand Ministry of Health recommends that children aged five- to 17-years, spend no more than two hours a day in recreational screen time. However, while these guidelines exist, studies repeatedly show that children spend more time using digital devices than is recommended by these organisations (Nwankwo, Shin, Al-Habaibeh, & Massoud, 2019).

In summary, considerable societal concern exists that screen time may be negatively impacting children's psychological well-being. Given this widespread concern, and the frequent, early, and increasing media use by children, it is critical that research investigates the impact of technology on child well-being. Accordingly, this thesis aims to examine the associations between screen time and psychological well-being in New Zealand primary school children.

## **Chapter Two: Child Well-being and Technology**

A considerable amount of research has been conducted to assess the potential psychological effects of digital technology on young people. These studies have repeatedly shown that the impact of screen-based technology use on well-being is unclear and research on primary school aged children is lacking. While some studies find that digital technology use is linked to poorer psychological well-being for young people, other studies find no links or links with improved well-being (Christakis et al., 2004; Coyne et al., 2020; Ferguson et al., 2021; Fors & Barch, 2019; Jensen et al., 2019; Landhuis et al., 2007). Furthermore, when negative associations are found, the effect sizes are frequently small, causing researchers to question the practical value of their results (Orben & Przybylski, 2019). Digital technology use by young people has been shown to be variably associated with internalising problems, externalising problems, and adaptive skills (Mistry et al., 2007; Twenge & Campbell, 2018; Van Egmond-Fröhlich et al., 2012).

### **Internalising Problems**

Given that digital media engagement is ubiquitous and often assumed to reduce social connection, it is commonly hypothesised that this digital engagement may cause internalising problems for youth. Internalising problems can be broadly defined as a group of psychological symptoms which are characterised by the maladaptive, overcontrol of emotions leading to behavioural and psychological symptoms (American Psychological Association, 2020; Merrell, 2008). Types of internalising disorders include, depressive disorders, anxiety disorders, and somatization problems (Hansen & Jordan, 2017). Mixed associations have been found between internalising symptoms and screen time in young people (Coyne et al., 2020; Fors & Barch, 2019; Houghton et al., 2018; Twenge et al., 2018).

## ***Depression***

There has been widespread speculation that current depression rates in young people have been affected by technology use (Morin, 2018; Twenge & Campbell, 2018). Several studies have concluded that depressive symptoms may, at least in some contexts, be associated with screen time in children and young people (Stiglic & Viner, 2019; Twenge et al., 2018). However, other studies report conflicting results (Ohannessian et al., 2009; Houghton et al., 2018).

Twenge et al. (2018) conducted one of the most widely publicised papers on depression and screen time in young people. In this study, a total of 506,820 American teenagers, took part in a series of cross-sectional data collection waves from 1991 to 2015. Depression symptoms and four suicide-related outcomes were measured. Screen time was assessed using global time estimate questions, asking for participants' total, average digital media use on weekdays and weekends. Correlation analyses found temporally linked, significant, positive associations between screen time and depressive symptoms and suicide-related outcomes. Interpreted, these findings could suggest that since 2011, teenagers have reported increasing levels of depressive symptoms, and this trend began at around the same time digital technology use has increased. Twenge et al. (2018) concluded that there was a clear link between screen time and depressive symptoms.

While Twenge et al.'s (2018) study has been widely influential in academic and public spheres, many researchers have questioned the validity of Twenge and colleagues' results (Ferguson et al., 2021; Heffer et al., 2019; Orben & Przybylski, 2019). For example, Heffer et al. (2019) conducted their study in response to Twenge et al.'s (2018) research and took their research one step further by using a longitudinal study design. In this study, one

sample of teenagers completed annual data collection over two years and one sample of undergraduate students completed annual data collection over six years. Depressive symptoms and social media use were measured. Autoregressive cross-lagged path analyses showed that, in both samples, social media use did not predict later depressive symptoms. In addition, depressive symptoms did not predict later social media use, except for in teenage girls. On the basis of these data, Heffer et al. (2019) concluded that their study found no evidence for the effect of social media on depression.

### ***Anxiety***

The research described above indicates conflicting evidence for the theory that digital media use may increase depressive symptoms. Subsequent research has suggested that the literature is similarly unclear about whether screen time is associated with anxiety (Boers et al., 2020; Comer et al., 2008). Research on this topic has theorised that exposure to scary or threatening digital media content may evoke a fear response, producing anxiety (Pearce & Field, 2016; Wilson, 2008). Most research findings in this field are mixed between small positive, negative, and null associations (Boers et al., 2020; Comer et. al., 2008).

Cross-sectional studies have found some significant associations between anxiety and screen time. For example, Fors and Barch (2019) investigated the association between screen time and depression and anxiety in children aged nine- to 11-years. In this study, 4,139 children and their parents or guardians completed questionnaires about child digital media use, depression, and anxiety. The authors found that both child- and parent-reported screen time was significantly associated with parent-reported child anxiety and depression symptoms. However, when controlling for depression, no screen time measure remained significantly associated with anxiety. On the other hand, when controlling for anxiety, all

depression and screen time associations remained significant. Small effect sizes for these associations were also noted by the authors. Fors and Barch (2019) concluded that child screen time was more strongly associated with depressive symptoms than anxiety.

While Fors and Barch (2019) found some support for the association between screen time and anxiety, longitudinal research into this topic has demonstrated further mixed results. For example, Boers et al. (2020) conducted a longitudinal study to investigate the relationship between screen time and anxiety symptoms in teenagers. This study used data from a longitudinal randomized trial of 3,659 of 12–13-year-olds who completed annual data collection over four years. Screen time and anxiety levels were self-reported. Multilevel linear modelling found that increased social media, television, and computer use were significantly associated with concurrent increases in anxiety symptoms, within the same year. No significant within person associations were found between anxiety and videogame play. However, all evidence was cross-sectional, and no lasting significant associations were found between screen time and anxiety over time. Boers et al. (2020) concluded that digital device use may be associated with concordant anxiety, however screen time does not produce lasting effects on anxiety over time.

Taken together, the studies described above present mixed evidence for the impact of digital media on the development of depression and anxiety symptoms in young people. In general, these studies typically report some small cross-sectional associations and some nonsignificant trends, while longitudinal evidence is scarce and even more mixed. Other studies in this field have reported similar results (see Table 1). Research in primary school aged children is also limited. However, when research in this younger age group has been

conducted, a mixed pattern of results mirrors findings in teenagers (Fors & Barch, 2019; Twenge & Campbell, 2018).

### **Externalising Problems**

Alongside the investigation of internalising problems and digital media use, there has also been concern that digital technology use may cause the development of externalising problems in young people. Externalising problems are characterized primarily by maladaptive behaviours which are displayed outwardly (American Psychological Association, 2020). Externalising disorders and behaviours include, conduct disorders, aggressive behaviour, and attention and hyperactivity disorders (Frick & Kimonis, 2005). Similar, to research on internalising problems, current research presents mixed evidence for the link between externalising symptoms and screen time in children (Christakis et al., 2004; Landhuis et al., 2007; Özmert et al., 2002; Van Egmond-Fröhlich et al., 2012).

### ***Hyperactivity and Attention***

A growing body of literature has addressed the relationship between child screen time and hyperactivity and attention problems (Landhuis et al., 2007; Levelink et al., 2020; Van Egmond-Fröhlich et al., 2012). Multiple theoretical explanations for this link have been discussed. Researchers have theorised that digital devices display stimuli which require rapid changes in focus, producing later hyperactivity and attention problems because of a reduced ability to then focus on less attention-captivating tasks (Anderson et al., 1977; Christakis et al., 2004). Alternatively, others have hypothesised that digital media content is so exciting that activities which are not digitalised, such as reading, may seem boring by comparison, producing sustained attention problems (Radesky, 2018). Researchers have found significant positive, negative, and null associations linking digital media use and

hyperactivity and attention problems (Christakis et al., 2004; Gentile et al., 2012; Levelink et al., 2020; Swing et al., 2010).

Cross-sectional evidence indicates some evidence for significant associations between child screen time and hyperactivity and attention problems. For example, Van Egmond-Fröhlich et al. (2012) conducted a cross-sectional study to investigate this relationship in children, aged six- to 17-years. Child hyperactivity and attention symptoms and television and video viewing time was reported by each child's parent. The study authors found that children's symptoms of hyperactivity and attention were significantly, positively correlated with television and video exposure, even after adjustment for potential confounders. Van Egmond-Fröhlich et al. (2012) concluded that although their study does not show causation, their results provide evidence linking concordant digital media exposure and hyperactivity and attention problems.

In contrast to Van Egmond-Fröhlich et al. (2012)'s research, a recent study has found less clear evidence for the link between child screen time and hyperactivity and attention. Levelink et al. (2021) investigated longitudinal associations between screen time and sleep in early childhood, and symptoms of attention-deficit hyperactivity disorder (ADHD) at primary school age. In this study, 2,768 Dutch mothers completed questionnaires about their child's screen time and sleep at age two, four, and six, and ADHD diagnosis at age eight to ten. ADHD symptoms were also measured at age eight, and at age two. General estimating equation logistic regression analyses revealed that screen time was not longitudinally associated with ADHD. However, the authors did find weak cross-sectional associations between time spent watching television and ADHD and hyperactivity and

attention problems at age two. Levelink et al. (2021) concluded that childhood screen time is not associated with ADHD symptoms.

### ***Aggression***

In addition to the mixed effects on hyperactivity and attention, child screen time has also been shown to be associated variably with aggression. The prevalence of violent digital media content has triggered the publication of many studies investigating how screen time affects children's aggressive behaviour (Calvert, 2015; Gentile et al., 2011; Ostrov et al., 2006). At present, there is considerable debate in this literature field (Drummond et al., 2020; Ferguson & Savage, 2012). Several authors have argued that their research findings provide support for the hypothesis that violent and general screen time increase young people's aggressive actions (Comstock, 2008; DeLisi et al., 2013; Johnson et al., 2002; Manganello & Taylor, 2009). However, other research challenges these findings (Ferguson & Savage, 2012; Ferguson & Wang, 2019).

Several longitudinal studies have found some links between exposure to violent digital media content and later aggression (Anderson et al., 2008; Hopf et al., 2008). For example, Johnson et al. (2002) investigated television viewing and aggression in a longitudinal study. A total of 707 children and their families took part in this study which monitored television viewing and aggressive behaviour at six data collection points, starting from ages one- to 10-years and finishing at approximately age 30. Parent and child reported aggressive behaviour and television viewing was recorded. Johnson et al. (2002) found significant associations between television viewing at early adolescence and later aggressive acts against other people. However, early television watching in childhood was not found to be significantly associated with later aggression. The authors concluded that high levels of

television viewing at early adolescence is associated with an increased chance of later aggressive acts against others.

Other research disputes the finding that digital technology use affects the development of aggression. For example, Ferguson and Wang (2019) conducted a longitudinal analysis of a dataset of 3,034 Singaporean teenagers who completed annual data collection over three years. Violent videogame exposure was measured at mean age 11-years and aggressive outcome variables were measured at mean age 13-years. Associations between violent videogame exposure with non-theoretically linked, nonsense variables were also calculated. These associations were calculated to allow effect sizes to be compared between associations with theoretically relevant and irrelevant outcomes, and therefore to determine if any results were likely to be chance findings. To reduce the likelihood of overinterpretation of chance findings, the authors also used an effect size cut-off for minimally interpretative results of  $r = .1$ . Regression analyses found that violent videogame exposure was not significantly associated with any later measures of aggression, over the set effect size and significance thresholds. However, one nonsense variable, 'age moved to Singapore' was significantly associated with violent videogame play and the association surpassed the  $r = .1$  effect size threshold. The authors concluded that results from their study do not support the conclusion that aggressive video games predict later aggression.

In summary, these suggest some evidence for and some evidence against the link between digital media exposure and externalising symptoms in children. A number of studies have provided additional evidence for these variable conclusions (see Table 1). Similar to research investigating internalising symptoms and digital media, a mixture of

small significant and not significant associations have been found. Research in this field focused on primary school children aged is again lacking.

### **Adaptive Skills**

Limited research has been conducted on the relationship between child screen time and adaptive skills. However, studies investigating communication and social skills indicate some variable evidence for a possible link (Hinkley & Brown, 2014; Mistry et al., 2007). Table 1 shows other studies in this area have reported mixed results, similar to the research discussed below.

### ***Communication and Social Skills***

Social skills can be defined as the ability to appropriately interact and communicate with others (Little et al., 2017). Evidence in pre-schoolers suggests that screen time and social skills may be associated (Hinkley & Brown, 2014; Hinkley et al., 2018; Mistry et al., 2007). For example, Mistry et al. (2007) investigated children's television use at 2.5 years and their social skills at age 5.5 years. Social skills were measured using the Social Skills Rating System. Television use was assessed using parent-reported daily hours of television watching and if a television set was present in the child's bedroom. Linear regressions were used to find that concurrent greater television exposure was associated with fewer social skills. However, no longitudinal associations were found. On the basis of these data, Mistry et al. (2007) concluded that continuing television viewing is a risk factor for poor social skills, however early exposure that is subsequently reduced produces no additional risk. Notably, the lack of a longitudinal association is unclear and could also indicate reverse causality, or that a third variable may explain the cross-sectional findings.

Research on this topic for primary school children is limited. However, one unpublished thesis has found associations between social skills and child screen time (Böðvarsdóttir, 2021). For this study 2,152 Icelandic children, aged 10-12-years, completed questionnaires about their screen time and social skills. Screen time was measured in global time estimates of self-reported digital media use each day. Social skills were measured by three questions about friendships and self-perceived likeability. Screen time was found to be significantly, negatively, linearly associated with social skills. However, effect sizes were considered small. In addition, effects differed depending on type of screen time. Playing videogames was not significantly related to social skills, watching television was negatively associated with social skills, and social media use was positively associated with social skills. The author concluded that this study supports the hypothesis that social skills are negatively associated with child screen time. On the other hand, the mixed associations in this study mirror the variable results found in the research described previously, investigating the relationship between digital media and both internalising and externalising problems.

### **Effect Size Debate**

One further debate in the digital technology and psychological well-being field is regarding the interpretation of the small effect sizes, which are commonly found in this field. Firstly, there is debate surrounding whether these small effect sizes are spurious and are found more often in this field because of their increased probability of developing under certain conditions including, methods variance and author bias (Ferguson & Heene, 2021; Orben & Przybylski, 2019). For example, some authors have suggested that methods including, demand characteristics, use of ineffective measures, and researcher expectancy effects may increase the probability of finding chance statistically significant results

(Ferguson, 2009; Ferguson & Heene, 2021). Furthermore, these results may be enhanced by publication bias, where authors and journal editors are more likely to publish small effect sizes if they support a previously set hypothesis.

Secondly, there is controversy about whether these statistically significant small effect sizes, when present, represent practically meaningful effects (Cohen, 1988; Odgers & Jensen, 2020a). Authors in this field have come to very different conclusions about the meaningfulness of results with similarly small effect sizes. Some researchers argue that when such results match an author's hypothesis, they may be over interpreted. Especially when most of the research in this field is cross-sectional, and longitudinal evidence is limited (Odgers & Jensen, 2020b). However, other researchers raise the point that even small effect sizes can generate large and practically meaningful effects when scaled up to the population level or are cumulative over time, especially when the outcomes are harmful (e.g., suicide or anxiety; Funder & Ozer, 2019).

Several studies have investigated the practical value of these small effect sizes further. For example, Orben & Przybylski (2019) explored the real world meaning of these small effect sizes in young people. In this study, Orben & Przybylski (2019) calculated the effect sizes of the associations between technology use and wellbeing in three large cross-sectional surveys of adolescents in the USA and UK. The authors found, across all three datasets, negative associations between technology use and wellbeing. However, the reported effect sizes were very small and less than  $\beta = .1$ . In addition, in one dataset and consistent with the other two, the authors found that the magnitude of the association between technology use and wellbeing was similar to the association between eating potatoes and wellbeing, and much smaller than the positive association between eating

breakfast and getting enough sleep and wellbeing. The study authors concluded that the association between technology use and adolescent wellbeing is small when considering a wider context, explaining at most 0.4% of the variation in wellbeing.

### **Technology and Well-being Theories**

The literature discussed so far reports mixed evidence for links between screen time and health and commonly reports associations with small effect sizes. The lack of clarity in the literature suggests the possibility of complex theoretical explanations, which may better explain the connection between these variables than simple linear associations. Several key theories have been proposed to explain this relationship.

#### ***The Displacement Hypothesis***

The majority of the research on the psychological impact of screen time is often, explicitly or implicitly, based on the displacement hypothesis. This is especially true in research investigating screen time and internalising problems. The displacement hypothesis is the theory that time spent using digital media is displacing time which could be spent in healthier activities, which may be protective for mental health, including sleep and face-to-face socializing with friends (Huston & Wright, 1998; Hall et al., 2019). This theory is based on the assumption that there is a limited amount of available time and energy which can be given to certain activities. However, despite some initial research supporting this theory, more recent research does not appear to support this idea that digital media use directly displaces the benefits of alternative activities (Kraut et al., 1998; Maccoby, 1951; Przybylski & Weinstein, 2017).

The seminal research paper published on the displacement hypothesis was conducted by Kraut et al. (1998) who investigated the impact of the introduction of internet

use on people's lives. In this study, 169 adults took part over their first one or two years with internet access and variables were assessed pre- and post-internet introduction. To measure internet use, software recorded the total hours per week each participant used the internet, and the number of emails and websites visited each week was recorded. Social involvement was measured by the participant listing number of people they typically socialise with at least once a month and the approximate number of minutes spent communicating with each of them. Social involvement was also measured using the social support scale, UCLA Loneliness Scale, and Centre for Epidemiologic Studies Depression Scale. Path analysis revealed that greater use of the internet was associated with reduced communication with family members, size of their social network, depression, and loneliness. In addition, the authors found that initial loneliness and depression did not predict later internet use. The authors concluded that, although the study does not show causation, it provided some evidence that the internet may displace social interaction.

However, while this early research tended to support the idea that digital activities were occurring at the expense of 'real' life activities, most current research has found that use of digital devices does not displace other activities. Current research has found that people who report greater communication on digital media do not report it reduces friendship quality, and even may have higher quality friendships (George & Odgers, 2015; Kraut et al., 2002), and do not report less time spent engaging in other activities including, hobbies and physical activity (Roberts & Foehr, 2004; Rosen, 2019). For example, Valkenburg and Peter (2007) examined this area in a survey of 794 Dutch 10-16-year-olds. They found that online communication was significantly positively related to the closeness of friendships for participants who primarily talked with existing, offline friends online.

These results suggest that young people are not substituting poorer quality online communications for more psychologically valuable real-life interactions.

### ***The Digital Goldilocks Hypothesis***

While recent evidence does not support the Displacement theory, one theory which has gathered substantial support, is the Digital Goldilocks Hypothesis (Przybylski & Weinstein, 2017). Previous research has theorised that the mixed results found in this literature field may be caused, at least in part, by nonlinear associations linking technology and psychological well-being (Przybylski & Weinstein, 2017). The Digital Goldilocks Hypothesis suggests that the relationship between digital media use and wellbeing may be curvilinear. According to the Goldilocks hypothesis, “too little” digital technology use can have a negative impact on young people by depriving them of key social information required to function and connect with peers in today’s digital world. In addition, use of high levels of digital technology may have a negative impact by displacing alternate activities, which are beneficial for mental health. Whereas moderate use of technology in our digital world may be “just right”, giving young people enough information to optimally function socially and enough time to spend in valuable activities, and therefore be psychologically advantageous. Thereby, this theory suggests that typical, moderate use of digital technology is not harmful to young peoples’ well-being. The mixed nature of this theory may also assist to explain the small effect sizes and variable results found in the literature.

The Digital Goldilocks theory is supported by a several recent large-scale studies of adolescents, showing curvilinear associations between adolescent technology use and wellbeing are curvilinear (Allahverdipour et al., 2010; Liu et al., 2016; Przybylski et al., 2020; Przybylski & Weinstein, 2017). The hallmark study of the digital Goldilocks hypothesis was

conducted by Przybylski and Weinstein (2017). In this study 120,115, English, 15-year-olds answered questionnaires assessing psychological well-being and time spent engaged in digital activities for leisure during the week and weekend. Regression models showed that curvilinear associations were statistically significant for all four types of digital activities and in the weekends and weekdays. Local inflection points were calculated for each type of digital media demonstrating where use switched from psychologically benign to harmful. For the weekdays, these points were: 1.67 hours for videogame play, 1.95 hours for smartphone use, 3.67 hours for watching videos, and 4.28 hours for using computers. The average effect sizes after these inflection points was  $-.18$ , and therefore after this point digital media use accounted for 1% or less of observed variability in mental wellbeing. Przybylski and Weinstein (2017) concluded that moderate screen time was not harmful to well-being, although high levels may have small negative impacts.

In summary, the rising popularity of digital media and concerns about their use has sparked considerable research into this area. Literature suggests mixed evidence for links between child digital media engagement and psychological health. Meta-analyses and reviews also support these conclusions, finding that research in this field is conflicting, and evidence is inconclusive (Stiglic & Viner, 2019; Suchert et al., 2015). Therefore, much debate still surrounds the theory of whether a meaningful association exists between the time spent using digital technology and lower psychological well-being. The Digital Goldilocks Hypothesis provides a plausible explanation for the relationship between well-being and screen time. This thesis will investigate if the Digital Goldilocks Hypothesis explains the relationship between digital media exposure and psychological wellbeing, including internalising problems, externalising problems, and adaptive skills, in primary school aged children.

**Table 1***Child Digital Technology Use and Psychological Outcomes (Depression, Anxiety, Attention, Hyperactivity, Aggression, and Social Skills)**Summaries of Research Published Between 2001 and 2021*

Psychological health variable	Author and year	Study design	Age range	Digital media form	Method	Results	Conclusion
Internalising Problems – depression and anxiety	Coyne et al. (2020)	Longitudinal	13–20-year-olds	Social Media	American teenagers (n = 500) annually interviewed face-to-face for 8 years. Social media use was self-reported using global time estimate questions. Depression was assessed using the Centre for Epidemiological Studies Depression Scale for Children. Anxiety was measured with the Spence Child Anxiety Inventory generalized anxiety disorder subscale.	For between person cross-sectional and longitudinal analyses social media use was moderately positively associated with depression and anxiety (autoregressive latent-trajectory models: girls: 0.42, $p < .001$ , boys: 0.39, $p < .001$ ). No significant within person associations were not found.	Found little evidence that time spent using social media may affect teenagers' levels of depression and anxiety over time.
Internalising problems – depression and anxiety	Fors & Barch (2019)	Cross-sectional	9-11-year-olds	Television, movies, videos, video games, texting,	Parents or guardians of children (n= 4,139) completed The Child Behaviour Checklist about child anxiety and depression. Screen time	Screen time was significantly associated with anxiety (week, $\beta = 0.03$ , $p = .12$ ; weekend, $\beta = 0.07$ , $p < 0.001$ ) and depression (week, $\beta = 0.04$ , $p = 0.01$ ; weekend, $\beta = .08$ , $p <$	Child screen time is more strongly associated with

				social media, video calling and total screen time	was assessed using 14 parent and child-reported global time estimates. Generalized linear mixed models were used, with nesting within the testing site and family.	0.001). When controlling for anxiety all depression and screen time analyses remained significant. However, when controlling for depression, anxiety analyses became non-significant.	depression than anxiety.
Internalising problems-depression and anxiety	Zhu et al. (2019)	Cross-sectional	6-17-year-olds	Television, videos, video games, computer, cell phone and other electronic devices	American children (n = 15,010) and teenagers (n = 20,708) were surveyed about diagnosed anxiety and depression. Screen time was measured using two global time estimate questions about device use for leisure.	Greater sleep and physical activity were associated with lower risk of depression and anxiety. Greater screen time was not associated with a higher risk of anxiety or depression. Meeting all sleep and screen time guidelines was associated with lower depression and anxiety (OR = 0.14 (0.03–0.64), $p < .05$ ).	Digital media engagement was not significantly associated with higher odds of an anxiety or depression diagnosis.
Internalising problems – depression and anxiety	Ohannessian et al. (2009)	Longitudinal	14-16-year-olds	Television, talking on the phone, text messaging, e-mailing/ IMing, video games	American teenagers (n = 328) were surveyed twice, one year apart.  Media use was measured using global time estimates. Depression was measured using the Centre for Epidemiological Studies Depression Scale for Children. Anxiety was assessed using the Screen	Longitudinally, most media use (television, talking on the telephone, e-mailing/ IMing, and text) was not associated with anxiety. Other media use (talking on the telephone, video games, e-mailing/ IMing, and text, surfing the internet) was not associated with depression. However, television use was found to be associated with depression ( $F$	Little evidence for the association between media examined and depression or anxiety. Results were mixed

					for Child Anxiety Related Disorders.	= 2.77, $p < .05$ ). Playing video games was associated with anxiety ( $F = 5.36, p < .05$ ).	for boys and girls.
Internalising problems – depression and anxiety	Kim et al. (2020)	Cross-sectional	12-17-year-olds	TV, movies, videos, leisure computer, laptop, tablet, or smart phone	2,320 Canadian teenagers self-reported screen time and depression, social phobia, generalized anxiety disorder, and specific phobia was assessed using the Mini International Neuropsychiatric Interview for Children and Adolescents.	Teenagers with over four hours of passive daily screen time were three times more likely to have experienced depression ( $OR = 2.73, p < .01$ ), social phobia ( $OR = 3.30, p < .01$ ), or generalized anxiety disorder ( $OR = 2.80, p < .01$ ), in the last six months. No associations between internalising symptoms and active screen time were found.	Passive screen time use was associated with internalising disorders. However, active screen time was not.
Internalising problems- anxiety, depression, withdrawal, somatization	Perrino et al. (2019)	Longitudinal	13-15-year-olds	Television, video/ computer games, instant messaging, emailing, texting, browsing the internet, and telephone use.	Hispanic American teenagers ( $n = 370$ ) completed initial data collection, and then at the 6-, 18- and 30-months following. Leisure screen time was measured using the Physical Activity Questionnaire for Adolescents' Sedentary Behaviour subscale. Internalising symptoms were measured using the Youth Self-Report	Cross-sectionally, internalising symptoms were positively correlated with screen time. Longitudinally, screen time and internalising symptoms were also significantly related. Bidirectionally, initial screen time did not predict internalising symptoms. Initial internalising symptoms were not associated with later screen time, except for among girls at only the last two study	Correlational evidence was found for the link between internalising symptoms and screen-based activities. Longitudinal evidence is gender dependent.

					measure internalising subscale.	time points. This association was small.	
Internalising problems - anxiety	Boers et al. (2020)	Longitudinal	12-16-year-olds	Video games, social media, videos or movies, and other computer use activities	3,659 teenagers completed annual data collection over four years. Anxiety symptoms were measured using the Brief Symptom Inventory-Anxiety subscale. Screen time was measured using average, daily, self-reported time spent engaged with digital devices.	Significant correlational associations between screen time and anxiety (e.g., social media (between-person: .43, within person: .21), television (between-person: -.12, within person: .15)). No significant associations were found between anxiety and videogame play. No longitudinal associations were found.	Concordant screen time and anxiety may be associated. However, screen time does not cause lasting effects on anxiety.
Internalising problems-depression	Houghton, et al. (2018)	Longitudinal	10-17-year-olds	Social media, television, gaming, and web browsing	1,749 teenagers completed data collection at six time points over two years. Depression symptoms were assessed using the Children's Depression Inventory 2 <sup>nd</sup> Edition and screen time using the Screen Based Media Use Scale.  Analyses used latent growth curve modelling.	Teenagers in a 'low-increasing' depression group reported increased screen time over the study. However, teenagers in 'low-stable' and 'high-decreasing' depression groups had relatively stable screen time over the study. Overall, small, cross-lagged associations between screen time and depression were found: Depression → total screen time ( $b = 0.15, p = 0.00$ ); Total screen time → Depression ( $b = 0.13, p = 0.02$ ).	No consistent evidence was found for a longitudinal and therefore causal associations between screen time and depression.

Internalising problems-depression	Primack et al. (2009)	Longitudinal	12-18-year-olds	Television, videocassettes, computer games, and radio	Teenagers (n = 4,142) who were not depressed in 1994 but then developed depression seven years later in 2002 completed the Centers for Epidemiologic Studies–Depression Scale. Global time estimate questions were used to measure digital media use.	Total digital media use (OR = 1.05) and television (OR = 1.08) use was associated with greater odds of developing depression. This risk was greater for men compared with women. No significant associations were found between depression and individual video, computer games, or radio engagement.	Watching television and total screen time are associated with later increased risk of adolescent depression.
Internalising problems - depression	Heffer et al. (2019)	Longitudinal	11-26-year-olds	Social media	Two samples; Canadian teenagers (n= 594), completed annual data collection over two years and undergraduate students (n= 1,132), completed annual data collection over six years.  Depression was measured using the Center for Epidemiologic Studies Depression Scale. Social media use was assessed using global time estimates.	For both samples, social-media use did not predict depression. Depressive symptoms were found to predict later social media use levels only for teenage girls. Autoregressive cross-lagged path analysis showed for teenagers: social media time 1 → Depression symptoms time 2 (Females: $\beta = -0.04$ , not significant; Males: $\beta = 0.15$ , not significant.), depression time 1 → social media time 2: (Females: $\beta = 0.13$ , $p < .05$ ; Males: $\beta = 0.09$ , not significant.)	This study found no evidence that social media use leads to depressive symptoms.
Internalising problems - depression	Sampasa-Kanyinga	Cross-sectional	11-20-year-olds	TV, movies, video, computer	10,183 Canadian students self-reported digital media use using several global	Spending two hours or less daily using digital media was not associated with suicidal	Adhering to screen time guidelines is

	et al. (2020)			games, chatting on a computer, emailing, or surfing the Internet	time estimate questions. Two questions were used to assess suicidal behaviour.	behaviour for girls and for boys, aged 11-14-years. However, meeting these guidelines was associated with lower odds of suicidal ideation (OR = 0.24) and suicide attempts (OR = 0.08) for boys aged 15- 20-years.	related to less risk of suicidality in older teenage boys.
Internalising problems - depression	Twenge et al. (2018)	Cross-sectional	13-18-year-olds	Computer games, videogames, social media, and television	American teenagers (n = 506,820) took part in a series of cross-sectional data collection waves from 1991 to 2015. Depression was measured using the Bentler Medical, the Psychological Functioning Inventory depression scale and four self-reported suicide-related items. Screen time was measured using global time estimate questions about weekday media use. Weekend television use was also measured.	Significant positive associations between screen time and depressive symptoms and suicide-related outcomes at separate cross-sectional waves. 1 <sup>st</sup> dataset: social media (Bivariate $r = 0.06, p < .001$ ); TV viewing (Bivariate $r = 0.03, p < .001$ ); internet news (Bivariate $r = 0.01, p < .001$ ). 2 <sup>nd</sup> dataset: device use (Bivariate $r = 0.12, p < .001$ ). Teenagers using digital devices for three or more hours daily were 34% more likely to report a suicide-related outcome than teenagers reporting less than two hours of daily use.	There was a clear link concluded between screen time and depressive symptoms.
Internalising problems – depression	Do et al. (2013)	Cross-sectional	13-18-year-olds	Internet use	Investigated self-reported sleep and well-being in South Korean adolescents	A significant curvilinear relationship between internet use and depression. Increased internet use was associated	Excessive internet use was associated

					(n = 136,589), while considering internet use. Leisure internet use was measured using one global time estimate item. Depression was measured using a single item asking about experienced sadness or despair.	with lower depression levels and suicidal ideation up to 90–124 min per day ( $-0.07, p < .01$ ) and then the trend reversed in sign at 129–180 min of use (0.03, not significant) and remained at 184–630 min of use ( $0.19, p < .01$ ).	with depression indicators.
Internalising and Externalising problems - anxiety, depression, somatic symptoms, attention deficit hyperactivity disorder	Ferguson & Wang (2021)	Longitudinal	11-13-year-olds	Video-games	Singaporean teenagers (n=3034) completed annual data collection over three years. Depression was assessed by the Asian-American Depression Scale. Anxiety, somatization, and ADHD was assessed by using related 20-, 10- and 18-item scales. Violence was measured by self-reported frequency of playing three video games. The violent content of each selected game was then rated.	Ordinary least squares regression equations found that time spent playing videogames and aggressive video games use did not predict later psychological health. Time spent gaming did not predict psychological health outcomes generally, with all effect sizes less than 0.1.	Playing violent videogames and time spent playing videogames has little effect on the later development of psychological health problems.
Internalising and Externalising problems -	Jensen et al. (2019)	Longitudinal	9-17-year-olds	Phone, internet, social media,	Teenagers (n=388) completed two sets of data collection, one year apart. Conduct problems	Teenagers' initial technology use did not predict later psychological health	Little evidence was found for

conduct problems, attention problems, general psychological distress, anxiety, depression	playing games, videos	were assessed using the Problem Behaviour Frequency Scale. Inattention and hyperactivity were assessed using ecological momentary assessment. Anxiety and depression were measured using the Positive and Negative Affect Schedule for Children. Daily technology use was measured using global time estimates.	symptoms more than baseline risk.  Found only three, out of 48 curvilinear associations studied, to be statistically significant. The effect sizes for these associations were small, all $\beta$ s < 0.11, $p$ 's < .01, and driven by a very small number of participants, as only in the very far edges of the distribution did the U-shaped association become positive or negative.	longitudinal associations between technology and psychological health.			
Internalising and Externalising problems - conduct problems, attention problems, anxiety, depression	George et al. (2018)	Longitudinal	11-15-year-olds	Social media, using the Internet, and texting	Teenagers (n = 151) at risk for mental health problems completed a 30-day ecological momentary assessment and a follow up a year and a half later.  Technology use was measured with global time estimate questions of daily use and ecological momentary assessments (EMA) administered by text.	Multilevel regression models found technology use was associated with ADHD ( $b = 0.05$ , $p = .002$ ), and conduct disorder symptoms on the same day ( $b = 0.13$ , $p < .001$ ) Text messages sent during EMA was also associated with poorer self-regulation and greater conduct problems between baseline and follow-up ( $b = 0.02$ , $p = .01$ ). More time online, and text messages were associated with less anxiety and depression.	Small associations were found between technology use and same day ADHD and Conduct Disorder symptoms.

Internalising problems, Externalising problems, and Adaptive Skills	Przybylski, (2014)	Cross-sectional	10-15-year-olds	Computer and console games	<p>4,899 teenagers completed the Strengths and Difficulties Questionnaire to measure Internalising, externalising problems, and prosocial behaviour.</p> <p>Electronic game engagement was measured using two self-report items, about console-based games and computer-based games.</p> <p>Life satisfaction was measured by asking participants to rate their total level of happiness and across five life domains (school, school, appearance, family, and friends).</p>	<p>Low digital game engagement was associated with greater prosocial behaviour (<math>bs = 0.19</math> to <math>0.31</math>) and life satisfaction (<math>b = 0.10</math> to <math>0.12</math>) and lower internalising symptoms (<math>bs = 20.37</math> to <math>20.52</math>) and externalising symptoms (<math>bs = 20.64</math> to <math>20.68</math>) compared with nonplayers (<math>ps &lt; .001</math>).</p> <p>High levels of game play were associated with higher levels of internalising (<math>bs = 0.72</math> to <math>0.92</math>) and externalising problems (<math>bs = 1.12</math> to <math>1.17</math>) and lower levels of prosocial behaviour (<math>bs = 20.27</math> to <math>20.50</math>) and life satisfaction (<math>bs = 20.17</math> to <math>20.20</math>) compared with nonplayers (<math>ps &lt; .001</math>).</p> <p>Moderate levels of play were not associated with psychological variables.</p>	<p>Results suggest that low levels of daily digital game engagement may be beneficial for children. However, greater levels of play may be linked to negative psychological outcomes.</p>
Internalising problems and Externalising problems – depression and aggression	Durkin & Barber (2002)	Cross-sectional	16-year-olds	Computer games	<p>1,304 American teenagers self-reported computer game use with a global time estimate item.</p> <p>Aggression was measured using items about</p>	<p>Participants who played computer games generally had more positive mental health than teens who never played. Curvilinear associations between videogame use and depression and aggression</p>	<p>Concluded that playing computer games can be a positive part of</p>

					frequency of punching and pushing around other students in the previous 6 months. Depressed mood was measured with a four-item scale related to depression symptoms.	were found. Never use (Depression mean and SD: 4.16, 1.30; Aggression mean and SD: 1.94, 1.30), Low use (Depression mean: 3.95, 1.17; Aggression: 1.85, 1.29), and high use (Depression mean: 4.18, 1.21; Aggression: 2.14, 1.64). Groups were significantly different (Depression: $F = 4.19, p < .05$ ; Aggression: $F = 2.76, p < .05$ ).	healthy adolescence.
Externalising problems – Hyperactivity and attention problems	Van Egmond-Fröhlich et al. (2012)	Cross-section	6-17-year-olds	Television and video watching	Parents of children ( $n = 11,676$ ) were surveyed about hyperactivity and attention symptoms using the Strengths and Difficulties Questionnaire hyperactivity/inattention subscale. Screen time was measured using a global time estimate item about weekday and weekend viewing.	Hyperactivity and attention were significantly, positively correlated with television and video exposure, even after adjustment for potential confounders including, age, sex, socioeconomic status ( $B = 0.021, p = 0.00$ ). Associations were also found between attention and hyperactivity symptoms and other variables including diet.	Results contribute to evidence linking digital media exposure and hyperactivity and attention problems.
Externalising problems – Hyperactivity and attention problems	Landhuis et al. (2007)	Longitudinal	5-15-year-olds	Television	The parents of 1,037 children estimated their child's television viewing using weekday global time estimates at ages 5, 7, 9, and 11 years and	Linear regression models revealed that childhood television watching predicted teenage attention problems, even when controlling for gender, early attention	Findings support the hypothesis that childhood television

					attention problems at ages 13 and 15 years using the Quay and Peterson Revised Problem Behaviour Checklist. Teacher-reported attention using the Rutter Child Scale. Self-reported attention problems were collected using the Diagnostic Interview Schedule for Children.	problems, cognitive ability, and socioeconomic status. For each hour of television viewing, the odds ratio for high teenage attention problems was 1.44.	viewing contributes to later attention problems.
Externalising problems – Hyperactivity and attention problems	Levelink et al. (2021)	Longitudinal	2-10-year-olds	Television and computer games	Dutch mothers completed questionnaires about their child's (n=2,769) screen time using global time estimates of daily screen time outside school hours, and sleep at age 2, 4, and 6, and ADHD at age 8 to 10. ADHD was measured using parent- and doctor-reported diagnosis of ADHD at 8, and the Child Behaviour Checklist/2-3 externalising scale at 2.	General estimating equation logistic regression analyses revealed that screen time was not longitudinally associated with ADHD. However, the authors did find weak cross-sectional associations between time spent watching television and ADHD and hyperactivity and attention problems at age two.	Childhood screen time and is not associated with ADHD symptoms.
Externalising problems – hyperactivity	Gentile et al. (2012)	Longitudinal	8-17-year-olds	Video-games	3,034 children self-reported videogame use and attention problems using the Current ADHD	Total videogame exposure and violent videogame exposure were associated with impulsiveness and attention	Findings support the hypothesis that

and attention problems	<p>Symptoms Scale Self-Report, and Barratt Impulsiveness Scale-11 annually for three years.</p> <p>Videogame use was measured in the morning, afternoon, and evening, on a typical week and weekend day.</p> <p>Analyses used General linear models with sex, age, race, and socioeconomic status as covariates.</p>	<p>problems (attention and total exposure: <math>F = 47.47, p = .00</math>; attention problems and violent videogames: <math>F = 22.74, p = .00</math>; Impulsivity and total exposure: <math>F = 32.61, p = .00</math>; Impulsivity and violent videogames: <math>F = 14.05, p = .00</math>).</p> <p>In the two time-lagged impact models, only total video game exposure predicted attention and impulsivity (attention and total exposure: <math>F = 47.28, p = .04</math>; impulsivity and total exposure: <math>F = 4.34, p = .04</math>).</p>	videogame play is associated with later development of attention problems.
Externalising problems – aggression	<p>Hopf et al. (2008)</p> <p>Longitudinal</p> <p>10-15-year-olds</p> <p>Films and videogames</p> <p>German children (n = 314) were surveyed over two years. To assess aggression, a scale for violence beliefs, delinquency, acceptance within the family, verbal aggression, physical aggression, and deviance in school was used.</p> <p>Media violence was assessed by reported frequency of watching</p>	<p>Multiple regression algorithms showed that childhood media exposure was linked with adolescent aggression and delinquency.</p> <p>Path analyses revealed that early exposure to violent films most strongly caused adolescents' aggression and exposure to violent videogames most strongly caused later delinquent behaviour (media violence</p>	Findings confirm the causal impact of violent media exposure on later aggression.

					horror and violent films and videogames in a list of many well-known options, to produce a total media violence exposure score.	exposure (total) and violence beliefs: $r = 0.34, p < .01$ ; students' violence: $r = 0.47, p < .01$ ; delinquency: $r = 0.48, p < .01$ ).	
Externalising problems – aggression	Johnson et al. (2002)	Longitudinal	1-30-year-olds	Television	707 children and their families took part at six data collection points, starting from ages 1- to 10-years and finishing at approximately age 30.  The parent and youth Diagnostic Interview Schedule for Children was used to measure aggressive behaviour. Children and parents were interviewed to collect television viewing times.	Significant associations were found between television viewing at early adolescence and later aggression (assault or physical fights resulting in injury: OR = 2.62; robbery, threats to injure someone, or weapon used to commit a crime: OR = 1.26; any aggressive act against another person: OR = 1.57). However, longitudinally, early childhood television watching was not found to be associated with later aggression.	High television viewing at adolescence is associated with increased risk of later aggression. However, this was not true for childhood exposure.
Externalising problems – aggression	Ferguson & Wang (2019)	Longitudinal	11-13-year-olds	Videogames	Singaporean teenagers ( $n=3,034$ ) took part in annual data collection over three years. Violent videogame exposure was assessed by participants listing 3 video games they currently played, and time spent playing them. Entertainment Software	Regression analyses showed that violent videogame exposure was not significantly associated with any later measures of aggression.  However, one nonsense variable, 'age moved to Singapore' was significantly associated with violent	Results from this study do not support the conclusion that aggressive video games

					Ratings Board ratings for the games were used to rate violent content. Aggression was measured using 12 items on physical and relational aggression.	videogame play and the effect size surpassed the 0.1 minimum interpretation threshold: $R = -0.14$ .	predict later aggression.
Externalising problems – aggression	Robinson et al. (2001)	Experimental	8-9-year-olds	Television, videotape, and video game	Children reported peers' aggressive behaviour and perceptions on if the world is mean and scary. 60% of the children were watched for aggression on the playground. The Child Behaviour Checklist measured parent reported aggression and delinquency. An intervention to decrease screen time in some children was introduced.	Compared with control children in the intervention group were rated by their peers as presenting with statistically significant decreases in aggression (adjusted mean difference: -2.4%, $p = .3$ ) and observed verbal aggression (adjusted mean difference: -0.1 act per minute per child; $p = .1$ )	Results support the causal relationship between media and aggression in children.
Adaptive Skills	Mistry et al. (2007)	Longitudinal	2.5-5.5-year-olds	Television	Children's television use at 2.5 years was measured using parent-reported daily hours of use and their social skills at age 5.5 years. Social skills were measured using the Social Skills Rating System.	Concurrent greater levels of television exposure was associated with poorer social skills. Cooperation ( $\beta = -0.57, p < .05$ ), assertion ( $\beta = -0.45, p < .05$ ), self-control ( $\beta = -0.60, p < .01$ ), and total social skills score ( $\beta = -1.84, p < .01$ ). However, no significant longitudinal associations	Concurrent television watching is associated with fewer social skills. However sustained and early television

						between early television use and later social skills impact were found, once controls were adjusted for.	viewing is not associated with fewer social skills.
Adaptive Skills – social skills	Hu et al. (2020)	Cross-sectional	5-year-olds	Television, video, computer, phone, tablet	The parents of 579 Chinese children answered two global time estimates about their child's screen time. The parent version of the Social Skills Improvement System-Rating Scales was used to assess children's social development.	Hierarchical multiple regressions showed that passive screen time was negatively associated with children's social skills ( $B = -1.894$ , $\beta = -.113$ , $t = -2.639$ , $p < .01$ ). However, active screen time was not associated with social skills.	Passive screen time is negatively associated with social skills in young children.
Adaptive Skills – social skills	Böðvarsdóttir (2021)	Cross-sectional	10-12-year-olds	watching movies, series, or videos, using the internet, playing videogames and general computer use	2,152 Icelandic children answered questionnaires about their screen time and social skills. Social skills were measured by three questions about friendships and self-perceived likeability. Screen time was measured in global time estimates of self-reported daily digital media use.	Screen time was negatively, linearly associated with social skills ( $\beta = -.06$ , $p = 0.01$ ). Effect sizes were small. Effects differed depending on screen type. Playing videogames was not related to social skills, watching television was negatively associated with social skills and social media use was positively associated with social skills.	This study supports the hypothesis that social skills are negatively associated with child screen time.

### Chapter Three: The Present Study

In summary, digital media exposure is a prevalent and ubiquitous feature of young people's daily lives and has been variably associated with a variety of psychological outcomes for children. Given the literature in this area is mixed, the digital Goldilocks Hypothesis provides a promising explanation for the relationship between well-being and screen time in younger populations. The purpose of the present study is to assess if the digital Goldilocks hypothesis, in line with findings from studies of digital screen time in older children, explain associations between psychological wellbeing and screen time in New Zealand primary school children.

Specifically, it was hypothesised that there would be a curvilinear association between parent reported digital screen time variables (digital game play in the week and weekend, and video engagement in the week and weekend) and the Behaviour Assessment System for Children, Second Edition (BASC-2) parent and teacher rated internalising problems composite, externalising composite, and adaptive skills composite. Given the concerns in this research field about the discovery of spurious significant findings and the meaning of effect sizes, hypotheses were considered supported if relationships are significant and effect sizes are greater than a minimum effect size of  $\beta = .1$ . Therefore, we preregistered that we would be cautious about the interpretation of any associations with an effect size below  $\beta = .1$ .

#### Research Rationale

The review of the literature in Chapter Two indicates four primary rationales for conducting the present research. First, the existing findings on digital media consumption and wellbeing appear to be inconsistent. While some studies find negative associations

between wellbeing and digital media use, others find small, mixed or no associations (Cliff et al., 2016; Hinkley et al., 2014; Stiglic & Viner, 2019). Several studies have even yielded contradictory conclusions from analysis of the same large-scale datasets (Przybylski & Weinstein, 2017; Twenge & Campbell, 2019; Twenge et al., 2018). Furthermore, when negative associations are found between psychological wellbeing and digital media use the effect sizes are frequently small, causing some researchers to question the practical value of their results (Orben & Przybylski, 2019). These mixed findings have led to ongoing debate about the existence and importance of media consumption on wellbeing. Consequently, many researchers have called for further research into the impacts of digital media use on wellbeing to clarify the relationship between them.

Second, knowledge gaps have been identified in the extant literature for research on primary school aged children. Currently the bulk of the research has investigated digital media use and effects in teenagers. To date, little research has been conducted examining the effects of digital media on primary school aged children. For example, in one review of 1200 studies, only one fifth included any children under nine-years-old (Holloway et al., 2013). This younger age range has been overlooked because teenagers have been typically perceived to be greater consumers of digital media and are therefore conceivably reporting greater psychological health detriments as a result (Twenge et al., 2018). However, in contrast to this presumption, younger populations are now using technology at substantial rates (Graafland, 2018; OfCom, 2019; Rideout et al., 2010). This dramatic increase in digital media consumption by children has heightened the need for research to be conducted in this younger population.

Third, children are uniquely vulnerable to digital media exposure because their brains and bodies are still developing. Childhood is a period when rapid and significant neurodevelopment occurs (Nelson & Gabard-Durnam, 2020). Cognitive flexibility during childhood experiences has been shown to produce heightened long-term effects on brain development and behaviour (Langenhof & Komdeur, 2018; Zeanah et al., 2011). Further, there are widely accepted 'sensitive periods' during childhood when the brain becomes uniquely sensitive to certain exposures (Oyama, 1979). In addition, digital media exposure this earlier age may result in the possible greater cumulation of any potential negative impacts over time. Therefore, any negative effects of digital media use may have greater and longer lasting effects on children than on adults, adolescents, or populations at other developmental phases. On the other hand, it is possible that this increased cognitive flexibility may mitigate any potential negative digital media effects. Therefore, it is particularly important to investigate the impacts of technology for this potentially vulnerable and unique younger population.

Fourth, to our knowledge, no previous studies have been conducted into the psychological effects of digital media exposure in children, aged six to eleven years old, in Aotearoa/New Zealand. Aotearoa/New Zealand presents a unique psychosocial and environmental landscape for research because of its socio-cultural characteristics, biculturalism, urbanisation, globalisation, and digital technology access demographics. In addition, children in Aotearoa/New Zealand also appear to consume substantial amounts of digital media, following international trends (Ministry of Health, 2017; New Zealand On Air and the Broadcasting Standards Authority, 2020). Given this considerable digital media use, New Zealand parents and organisations have reported concerns about the impacts of this

exposure (Dorey et al., 2010). Consequently, the investigation of the psychological effects of digital media on children in an Aotearoa/New Zealand context merits attention.

In summary, there are many important rationales for the current research. All of these points are heightened in light of global changes, including urbanisation and the COVID-19 pandemic, which are increasing the consumption of digital media worldwide (Meissel et al., 2021). The purpose of the present project is to investigate the association between digital technology use and psychological health outcomes in New Zealand primary school aged children. Specifically, we will examine whether the Digital Goldilocks Hypothesis explains the effects of video and movie watching and playing videogames on three psychological outcomes: internalising problems, externalising problems, and adaptive skills. This project analyses data collected before the 2020 and 2021 New Zealand COVID-19 restrictions.

## Chapter Four: Method

### Participants

A total of 703 (337 males, 366 females) 6- to 11-year-old participants took part in this study. Participants were recruited through primary schools throughout New Zealand as part of a larger project conducted by the Research Centre for Hauora and Health and the School of Psychology at Massey University. A summary of participant demographics can be found in Table 2. This sample contained an over-representation of New Zealand European children and under-representation of eleven-year-old children, compared to the other age groups.

**Table 2**

*Summary of Participant Demographics*

Variables	Age Group (years)						Total
	6	7	8	9	10	11	
Ethnicity							
NZ European	128	122	94	114	97	56	611
Māori	12	17	15	11	14	6	75
Other	2	3	1	4	6	1	17
n	142	142	110	129	117	63	703

Note. Ethnicity was prioritised according to Ministry of Health codes (Ministry of Health, 2004).

### Measures

#### *Digital Media Engagement*

To measure child digital media engagement, parents or caregivers completed five questionnaire items about the digital media consumption of their child.

#### **Digital Game Play**

To measure the amount of time participants spent playing digital games, parents or caregivers responded to two global time estimate questions. Parents or caregivers were

asked to specify how much time their child spends playing digital games during the week by responding to the question, *“How much time does your child spend playing computer or video games on a typical weekday?”*. Parents/caregivers were asked to specify the duration their child’s weekend videogame play by answering the question, *“How much time does your child spend playing computer or video games on a typical weekend day?”*. For both questions, parents or caregivers responded using a free response, hours per day format.

### **Television, Video and Movie Watching**

To assess the amount of time participants spent watching videos and movies participants’ parents or caregivers responded to similar global time estimate questions about video engagement. Parents or caregivers estimated their child’s video engagement with videos and movies on a weekday by answering the question, *“Think for a moment about a typical weekday for your family. How much time would you say your child spends watching TV/DVDs or movies on a computer/phone on a typical weekday (either in your home or elsewhere)?”* Parents or caregivers estimated their child’s engagement with videos and movies on a weekend day by responding to the item, *“Now, think about a typical weekend day (Saturday or Sunday) for your family. How much time would you say your child spends watching TV/DVDs or movies on a computer/phone on a typical weekend day (either in your home or elsewhere)?”*. For both questions, parents or caregivers responded using a free response, hours per day format.

### **Parent-Reported Psychological Well-being**

Participants’ level of psychological wellbeing was measured using the Behaviour Assessment System for Children, Second Edition (BASC-2), Parent Rating Scale, Child Form (for ages 6 to 11). The BASC-2 measures problem and adaptive behaviour and emotions in

children, aged 6-11-years old. The Parent BASC-2 is comprised of four composites: the externalising problems composite, internalising problems composite, adaptive skills composite, and the behavioural symptoms index. The first three of these composites were analysed in the present project. Parents and caregivers rated their child's behavioural frequency on 160 statements using a 4-point scale (1 = never, 2 = sometimes, 3 = often, 4 = almost always). Results from all items were combined to produce the four behaviour composites described previously. The BASC-2 Parent Rating Scale, Child Form is a widely used measure, with excellent internal consistency across all composites (Cronbach's  $\alpha$ : Externalising Problems = .92-.94, Internalising Problems = .90, Adaptive Skills = .94-.95), good test-retest reliability (scale median  $r = .84$ ), and high convergent validity with other measures of behaviour between scales which assess similar constructs (correlations range from .65 to .84; Reynolds & Kamphaus, 2004).

#### **Externalising Problems Composite Parent**

To measure participants' levels of externalising problems, parents or caregivers rated their child's behavioural frequency on statements such as "*bullies, intimidates, or threatens others*" using a 4-point Likert scale (1= never, 4= almost always). This composite assesses disruptive behaviour problems and is comprised of three subscales: aggression, hyperactivity, and conduct problems.

#### **Internalising Problems Composite Parent**

To assess participants' levels of internalising problems parents or caregivers rated their child's behavioural frequency on statements such as "*is easily upset*" using a 4-point Likert scale (1= never, 4= almost always). This composite assesses problem behaviours which are not marked by acting out behaviour, and is comprised of three subscales: anxiety, somatization, and depression.

### **Adaptive Skills Composite Parent**

To measure participants' levels of adaptive skills parents or caregivers rated their child's behavioural frequency on statements such as "*organizes chores or other tasks well*" using a 4-point Likert scale (1= never, 4= almost always). This composite contains the subscales of adaptability, social skills, leadership, activities of daily living and functional communication.

### **Teacher-Reported Psychological Well-being**

Child psychological wellbeing was also measured by teachers completing the Behaviour Assessment System for Children, Second Edition (BASC-2), Teacher Rating Scale, Child Form (for ages 6 to 11) for each participating child. Teachers rated their child's behavioural frequency on 139 statements using a 4-point scale (1 = never, 2 = sometimes, 3 = often, 4 = almost always). Results from all questions were combined to produce the three behaviour composites described below. The BASC-2 Teacher Rating Scale, Child Form is a widely used measure, with excellent internal consistency across all composites (Cronbach's  $\alpha$ : Externalising Problems = .97, Internalising Problems = .88-.90, Adaptive Skills = .97), good test-retest reliability (scale median  $r = .86$ ), and high convergent validity with other measures of behaviour between scales which assess similar constructs (correlations range from .75 to .85; Reynolds & Kamphaus, 2004).

### **Externalising Problems Composite Teacher**

Teachers rated each child's behavioural frequency on statements such as "*argues when denied own way*" using a 4-point Likert scale (1= never, 4= almost always) assessing disruptive behaviour problems including, aggression, hyperactivity, and conduct problems.

### **Internalising Problems Composite Teacher**

Teachers rated each child's behavioural frequency on statements such as "*says, 'I get nervous during tests' or 'tests make me nervous.'*" using a 4-point Likert scale (1= never, 4= almost always) assessing problem behaviours that are marked by overcontrolled behaviour including, anxiety and depression.

### **Adaptive Skills Composite Teacher**

Teachers rated each child's behavioural frequency on statements such as "*responds appropriately when asked a question*" using a 4-point Likert scale (1= never, 4= almost always) measuring appropriate emotional expression and control, daily living and communication skills, prosocial behaviour, and other adaptive skills.

### **Control Variables**

Previous research has established associations between digital media engagement and psychological wellbeing and a variety of sociodemographic factors in children. These associated variables include age, gender, ethnicity, Body Mass Index (BMI), physical activity, child illness/disability, socioeconomic status (household income and New Zealand deprivation index level 2013), household urbanisation (urban/rural), parent marital status, parent/caregiver mental illness, parent/caregiver education, and family composition (biological father's presence and number of child's siblings in household). Therefore, these variables were considered in the analyses as control measures and adjusted for to help account for their possible confounding influence. Descriptive statistics for all variables of interest (means, medians, standard deviations, skew, kurtosis, minimums, and maximums) can be found in Tables 3, 4 and 5.

**Table 3***Summary of Digital Variables*

	Video Engagement	Video Engagement	Digital Game Play	Digital Game Play
	Week	Weekend	Week	Weekend
N	699	701	681	675
Mean	1.40	2.45	0.638	1.25
Median	1.00	2.00	0.50	1.00
Standard deviation	1.07	1.51	0.68	1.20
Minimum	0.00	0.00	0.00	0.00
Maximum	6.00	8.00	5.00	8.00
Skewness	1.24	1.03	1.91	1.64
Kurtosis	1.99	1.35	5.86	3.57

**Table 4***Summary of Parent-Reported Psychological Well-Being Variables (T Scores)*

	Externalising	Internalising	Adaptive Skills
	Composite	Composite	
N	702	700	699
Mean	48.0	47.6	48.6
Median	47.0	46.0	48
Standard deviation	8.99	10.3	8.50
Minimum	32	30	28
Maximum	86	96	80
Skewness	0.95	1.14	0.28
Kurtosis	0.09	0.09	0.09

**Table 5**

*Summary of Teacher-Reported Psychological Well-Being Variables (T Scores)*

	Externalising Composite	Internalising Composite	Adaptive Skills
N	199	196	198
Mean	45.80	49.90	54.60
Median	43.00	47.50	55.00
Standard deviation	6.44	10.10	7.78
Minimum	40	38	28
Maximum	73	94	71
Skewness	1.77	1.43	0.39
Kurtosis	3.11	3.07	0.26

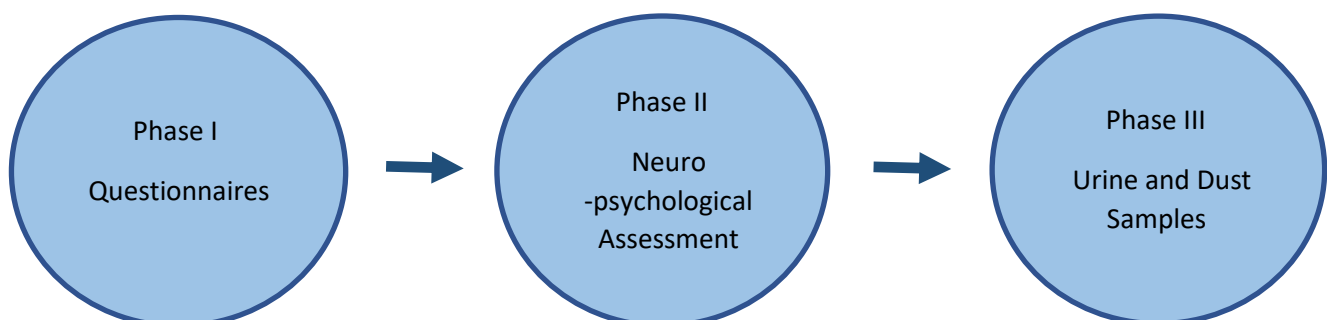
## Procedure

### *The RCHH Research Project*

The present master's research is nested within a larger project, which investigated pesticide exposure and neurodevelopmental effects in New Zealand children. This wider project was funded by the Health Research Council (HRC) and was reviewed and approved by the Central Health and Disability Ethics Committee (reference 13/CEN/134). The overall project was composed of three phases.

## Figure 1

*Outline of the three phases of the RCHH project.*



Phase I consisted of recruitment and participants completing three questionnaires. Children were recruited from throughout Aotearoa/New Zealand with the aim of recruiting 900 children. One of the primary goals of the RCHH research project was to assess the effects of exposure to pesticides and therefore, children were mainly recruited through schools selected based on their location in rural, urban, and farming settings. This selection was to ensure the assessment of children with a range of different pesticide exposure levels: 300 children living in an urban environment, 300 living in a rural environment, and 300 living on a farm.

In phase I, participating parents or guardians completed three postal questionnaires on behalf of their children. Phase II involved neuropsychological assessments for 447 children. Phase III involved the collection of urine and dust samples. For a summary of Phase II and Phase III please see Brinkmann (2018) or Ross-McAlpine (2018). The study was overseen by principal investigators from RCHH and the Massey University School of Psychology. Four assessors were involved with the collection of the neuropsychological data and multiple researchers assisted with recruitment activities. The author was involved in the coordination of the project after 2015 including recruitment, neuropsychological assessment, and the collection and processing of the urine and dust samples.

### ***The Present Project***

Participants were mainly recruited through primary schools in four New Zealand regions; Wellington, Hawke's Bay, Horowhenua and the Nelson/Tasman area. As mentioned previously, schools were selected based on their location, to ensure recruitment of rural, urban, and farming children. Schools were initially contacted through email and then followed up with a phone call or a face-to-face meeting with the school principal. Once a

school agreed to participate in the research invitation packs were provided to the school for the children to take home to their parents or guardians. These packs contained information sheets about the study, consent forms, and a postage paid return envelope. To increase response rates, two sets of reminder letters were given to all schools and a subset of schools received a presentation about the research. Written consent was then obtained from all parents, on behalf of their children, who agreed to take part in the research. Consenting parents were then sent the questionnaires for the first phase of the study in the post. Forty-one percent of parents (n= 1,985) from the primary schools responded to the invitation pack, 18% of parents (n= 885) provided consent of behalf of their children to take part in the research, of these 16% of parents (n= 770) completed and returned the postal questionnaires.

Participating parents or guardians completed three postal questionnaires on behalf of their children. The first, was the main questionnaire which collected general information about each participant including, demographic information (age, sex, ethnicity), child health indicators, child home environment, early life information, and current lifestyle factors. The second questionnaire was the Behaviour Rating Inventory of Executive Function (BRIEF). The BRIEF measures executive functioning in children, aged 5-18-years old. The third questionnaire was the Behaviour Assessment System for Children, Second Edition (BASC-2). Teachers of participating children were also invited to complete teacher versions of the BASC-2 and BRIEF for each child taking part. All questionnaires were completed and returned to the research team by post. Data from the exposure questionnaire and the Parent and Teacher BASC-2 questionnaires were analysed in the current thesis.

### ***Coding***

Responses on the BASC-2 Parent and Teacher Rating Scale were scored according to the guidelines provided for each measure (Reynolds & Kamphaus, 2004). Responses in the Adaptive Skill Composite were reverse scored so that a higher score represents poorer levels of adaptive skills, to bring these scores in line with the other composite scores. Participants' scores on the digital media use questions were considered separately for week and weekend videogame play and video and movie engagement. A cultural advisor was consulted regarding the coding of ethnicity data. Based on the advice received during consultation, 0 was assigned as the code for participants who were identified as New Zealand European and 1 was assigned as the code for those identifying with other ethnicities. This approach was deemed most practical given the circumstances because of the low ethnic diversity rates in the project's sample. Both household income and New Zealand Deprivation Index were used as measures of socioeconomic status. Current address was used to calculate New Zealand Deprivation Index levels for each participant.

### ***Analyses***

All analyses of curvilinear relationships, hypothesised by the Goldilocks Hypothesis, are based on Przybylski and Weinstein (2017) and Nelson and Simonsohn (2014). Quadratic relations were tested using two linear regression analyses conducted before and after empirically defined local inflection points. Inflection points were considered the points at which the slopes relating screen time to well-being approached zero before reversing in sign. For example, the point where null or positive relations shifts to having a negative relation. To address the importance of control variables, separate regression analyses were run with and without controls. Control variables were adjusted for in analyses if they were

significantly associated with the psychological wellbeing or technology use variables, or if including the control variable in the analyses changed the effect size by 20% or greater.

Significance testing involved two-tailed significance tests at the 95% confidence level ( $\alpha = p < .05$ ).

## Chapter Five: Results

A preregistered plan of this analytic strategy can be found at:

[https://osf.io/v4h83/?view\\_only=53be97f370c644d49a99b9d86efe4f66](https://osf.io/v4h83/?view_only=53be97f370c644d49a99b9d86efe4f66). In the first part of the analysis, the relationship between psychological well-being and digital media use was examined. To do this, a series regression models were conducted to examine whether there were any significant linear or curvilinear associations between the measures.

### Parent-Reported Well-being Associations

Table 4 shows regression coefficients and significance levels for each model linking the parent-reported psychological well-being measures (externalising composite, internalising composite, and adaptive skills composite) with each digital media measure (watching television, videos, and movies, and playing computer and video games). These analyses indicated that, contrary to our hypotheses, only a few quadratic relations linking these variables reached significance. Significant curvilinear associations were found between the adaptive skills composite and time spent watching television, videos, and movies in the week ( $\beta = 0.07, p = .003$ ), the internalising composite and time spent watching television, videos, and movies in the week ( $\beta = -0.06, p = .03$ ), and the internalising composite and time spent playing digital games on the weekend ( $\beta = 0.05, p = .04$ ). All these effect sizes were small and less than  $\beta = 0.1$ , the study's pre-registered threshold for cautious interpretation.

On the other hand, significant linear associations were found between video engagement on weekdays and weekends, and all the psychological well-being composites. The effect sizes for these linear associations were all greater than  $\beta = 0.1$ . The smallest beta coefficient was for the Externalising Composite (weekday use:  $\beta = 0.10, p = .007$ ) and the

Adaptive Skills Composite (weekday use:  $\beta = 0.10$ ,  $p = .008$ ; weekend day use:  $\beta = 0.10$ ,  $p = .006$ ), and the largest  $\beta$  score was for the Internalising Composite (weekday use:  $\beta = 0.16$ ,  $p < .001$ ). In contrast, no significant linear associations were found between time spent playing digital games and the psychological well-being variables, except for between adaptive skills and weekend use ( $\beta = -0.12$ ,  $p = .002$ ).

### **Teacher Reported Well-being Measures**

For the teacher reported psychological well-being measures, virtually no significant linear or curvilinear associations were found to link these variables with the digital media use variables ( $ps > .10$ ). One exception to this lack of significance, was the significant linear association between the adaptive skills composite and time spent playing computer or video games in the weekend ( $\beta = 0.15$ ,  $p = .03$ ). The effect sizes for the rest of these associations were small, ranging from  $\beta = -0.0004$ , to  $0.10$ .

**Table 6**

*Results of Models Linking Parent-Reported Psychological Well-Being and Digital Technology Use Without Adjustments for the Control Variables*

	$\beta$	SE	95% CI	$p$
Watching Television, Videos, and Movies				
Externalising Composite				
Week				
Linear	<b>0.10</b>	0.32	[0.03, 0.18]	<b>0.007</b>
Quadratic	-0.04	0.19	[-0.41, 0.33]	0.09
Weekend				
Linear	<b>0.12</b>	0.23	[0.04, 0.19]	<b>0.001</b>
Quadratic	0.01	0.07	[-0.12, 0.16]	0.74
Internalising Composite				
Week				
Linear	<b>0.16</b>	0.36	[0.08, 0.23]	<b>&lt;0.001</b>
Quadratic	-0.06	0.22	[-0.49, 0.37]	<b>0.03</b>
Weekend				
Linear	<b>0.14</b>	0.26	[0.06, 0.21]	<b>&lt;0.001</b>
Quadratic	-0.03	0.12	[-0.27, 0.21]	0.20
Adaptive Skills Composite				
Week				
Linear	<b>0.10</b>	0.30	[0.03, 0.18]	<b>0.008</b>
Quadratic	-0.07	0.18	[-0.28, 0.42]	<b>0.003</b>
Weekend				
Linear	<b>0.10</b>	0.21	[0.03, 0.18]	<b>0.006</b>
Quadratic	-0.01	0.09	[-0.19, 0.17]	0.63
Playing Computer and Video Games				
Externalising Composite				
Week				
Linear	0.03	0.51	[-0.05, 0.10]	0.49
Quadratic	-0.03	0.36	[-0.74, 0.68]	0.15
Weekend				
Linear	0.06	0.29	[-0.01, 0.14]	0.10
Quadratic	-0.04	0.14	[-0.31, 0.23]	0.12
Internalising Composite				
Week				
Linear	0.05	0.58	[-0.03, 0.12]	0.24
Quadratic	-0.03	0.41	[-0.77, 0.83]	0.11
Weekend				
Linear	0.05	0.33	[-0.02, 0.13]	0.16
Quadratic	-0.05	0.16	[-0.26, 0.36]	<b>0.04</b>
Adaptive Skills				
Week				
Linear	0.07	0.48	[-0.003, 0.15]	0.06
Quadratic	-0.03	0.34	[-0.70, 0.64]	0.16
Weekend				
Linear	<b>0.12</b>	0.27	[0.04, 0.19]	<b>0.002</b>
Quadratic	-0.03	0.14	[-0.24, 0.30]	0.14

Note: Quadratic relations were tested while controlling for linear relations. CI = confidence interval. Bolded level of significance  $p < 0.05$  and effect size  $\beta \geq 0.1$ .

### Parent Reported Measures with Adjustments for Control Variables

The second part of the analysis investigated whether the addition of control variables would change the significance of the linear regressions linking time spent watching television, videos, and movies and the parent-reported psychological well-being measures. To do this, additional regression analyses for these significant linear analyses were run with adjustments for potentially confounding variables. Control variables were employed in these analyses if they were significantly associated with the psychological wellbeing or digital media use measure, or if the addition of the control variable in the analyses changed the effect size by 20% or greater. Control variables which met these specifications included, age, socioeconomic status (household income, parent education level, and New Zealand deprivation index rating), urbanicity, parent mental illness, parent marital status, family makeup, child medical diagnosis, BMI, physical activity levels, and meal consumption in front of the television.

Following adjustments for the control variables, the majority of the linear associations remained significant (largest  $\beta$  score for the Externalising Composite Weekend,  $\beta = 0.11$ ,  $p = .005$ , and the Internalising Composite Week,  $\beta = 0.11$ ,  $p = .009$ ; see Table 6). Figures 2 through 5 show linear regression effect sizes and 95% confidence intervals for the linear associations between all digital media and psychological well-being measures with and without control variables. In addition, the associations between the digital media use measures and the subscales of each psychological well-being composite were examined. These subscale analyses were generally consistent with the overall composite analyses. That is, all subscales analyses within a composite were generally of similar magnitude and direction to that composite (see Appendix A).

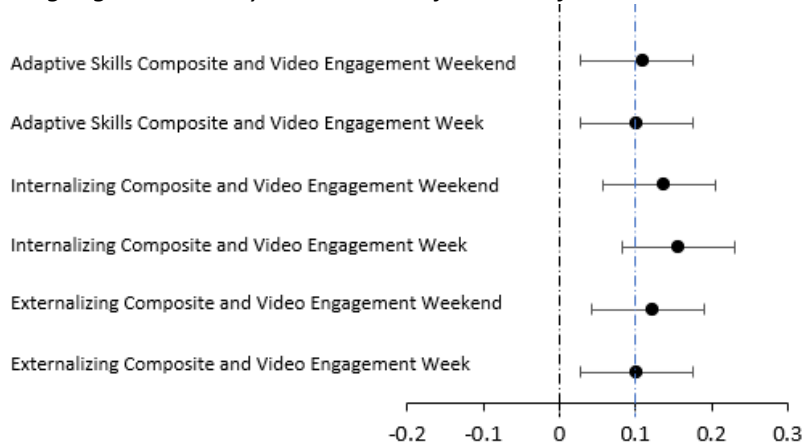
**Table 7***Results of Linear Regression Models Linking Psychological Well-Being and Digital Technology**Use with Adjustments for the Control Variables*

	$\beta$	SE	95% CI	$p$
Watching Videos and Movies				
Externalising Composite				
Week	0.09 <sup>bfi</sup>	0.32	[0.02, 0.17]	<b>0.014</b>
Weekend	<b>0.11</b> <sup>bfi</sup>	0.66	[0.03, 0.18]	<b>0.005</b>
Internalising Composite				
Week	<b>0.11</b> <sup>abcfijl</sup>	0.42	[0.03, 0.19]	<b>0.009</b>
Weekend	0.08 <sup>abcfijl</sup>	0.30	[-0.01, 0.16]	0.082
Adaptive Skills				
Week	0.09 <sup>defghik</sup>	0.30	[0.01, 0.16]	<b>0.019</b>
Weekend	<b>0.10</b> <sup>defhik</sup>	0.21	[0.02, 0.16]	<b>0.011</b>
Playing Videogames				
Adaptive Skills				
Weekend	<b>0.11</b> <sup>defghik</sup>	0.27	[0.03, 0.18]	<b>0.005</b>

Note: CI = confidence interval. Bolded level of significance  $p < 0.05$  and effect size  $\beta \geq 0.1$ . Control variables used: a = age, b = household income, c = parent education level, d = NZ deprivation index rating, e = urbanicity, f = parent mental illness, g = parent marital status, h = family makeup, i = child medical diagnosis, j = body mass index, k = physical activity levels, and l = meal consumption in front of the television.

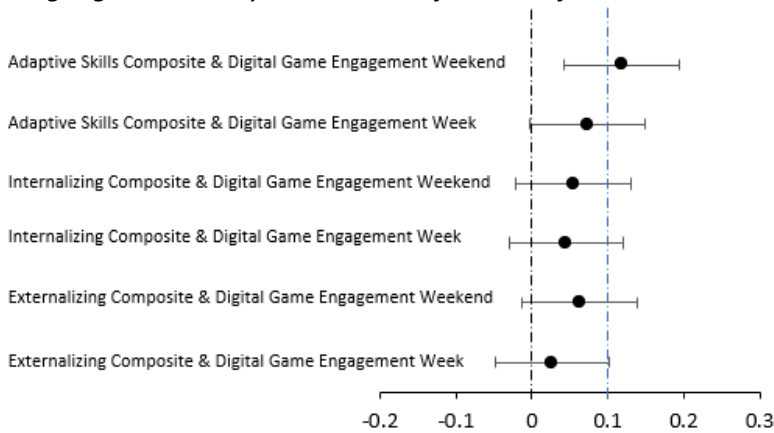
**Figure 2**

*Effect sizes and 95% confidence intervals for video engagement and well-being regression analyses without adjustments for the control variables*



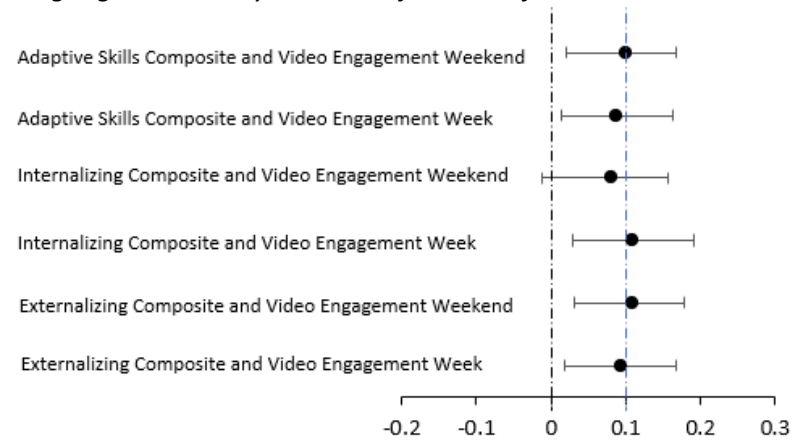
**Figure 4**

*Effect sizes and 95% confidence intervals for digital game play and well-being regression analyses without adjustments for the control variables*



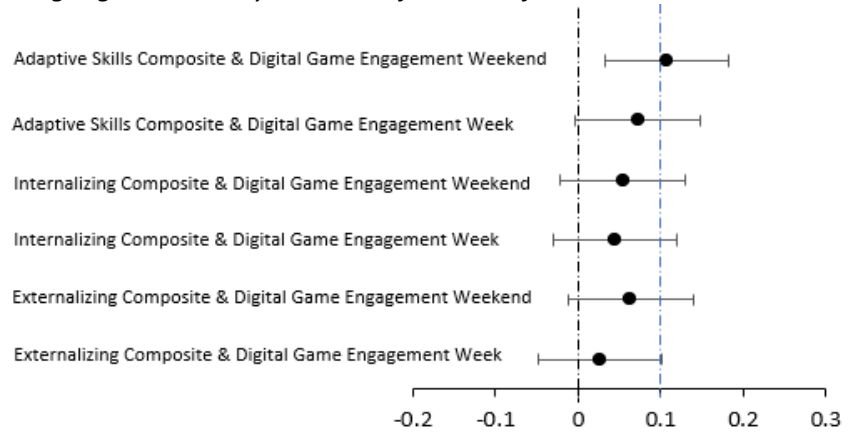
**Figure 3**

*Effect sizes and 95% confidence intervals for video engagement and well-being regression analyses with adjustments for the control variables*



**Figure 5**

*Effect sizes and 95% confidence intervals for digital game play and well-being regression analyses with adjustments for the control variables<sup>1</sup>*



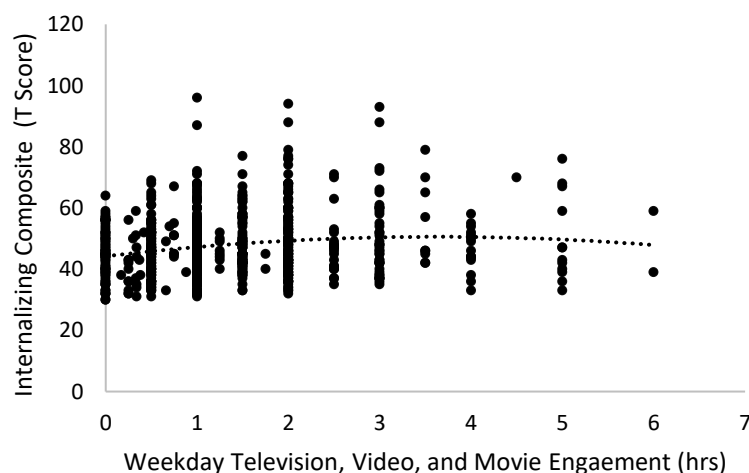
<sup>1</sup> Note: For the non-significant associations, controls were not added in because associations were already not significant

## Investigation of Curvilinear Associations

As discussed previously, there were three significant quadratic associations linking the parent-reported well-being and digital media use measures. These associations were the significant curvilinear association between the adaptive skills composite and time spent watching videos and movies in the week ( $\beta = 0.07$ ,  $p = .003$ ), the internalising composite and time spent watching television, videos, and movies in the week ( $\beta = -0.06$ ,  $p = .03$ ), and the internalising composite and time spent playing digital games on the weekend ( $\beta = 0.05$ ,  $p = .04$ ). Further investigation of these associations found the direction of these curvilinear relationships to be opposite to the trend predicted by the Goldilocks Hypothesis: greater and lower levels of digital media use were linked with fewer adaptive and internalising problems, while a moderate level of digital media use was linked with greater levels of adaptive and internalising problems (For an example see Figure 6). Recall that the adaptive skills composite has been reverse coded to for consistency with the other psychological well-being measures.

**Figure 6**

*Significant curvilinear association between the parent-reported internalising composite and weekday video engagement ( $\beta = -0.06$ ,  $p = .03$ )*



Following the study's pre-registered analysis plan, local inflection points were calculated for these quadratic associations. Then two linear regression analyses, one before and one after the maximum inflection points, were conducted. Table 6 shows maximum inflection points, regression coefficients, and significance levels for each significant curvilinear association linking well-being and digital media use. For the video engagement variables, the linear regressions below the inflection point were not significant (Adaptive:  $\beta = 0.12, p = .30$ ; Internalising:  $\beta = 0.12, p = .54$ ), while the regressions above the inflection point did reach significance (Adaptive  $\beta = -0.15, p < .001$ ; Internalising  $\beta = -0.19, p < .001$ ; see Table 6). The opposite pattern was observed for the digital game play variable (Internalising pre-inflection point:  $\beta = 0.10, p = .01$ ; post-inflection point:  $\beta = -0.11, p = .35$ ).

**Table 8**

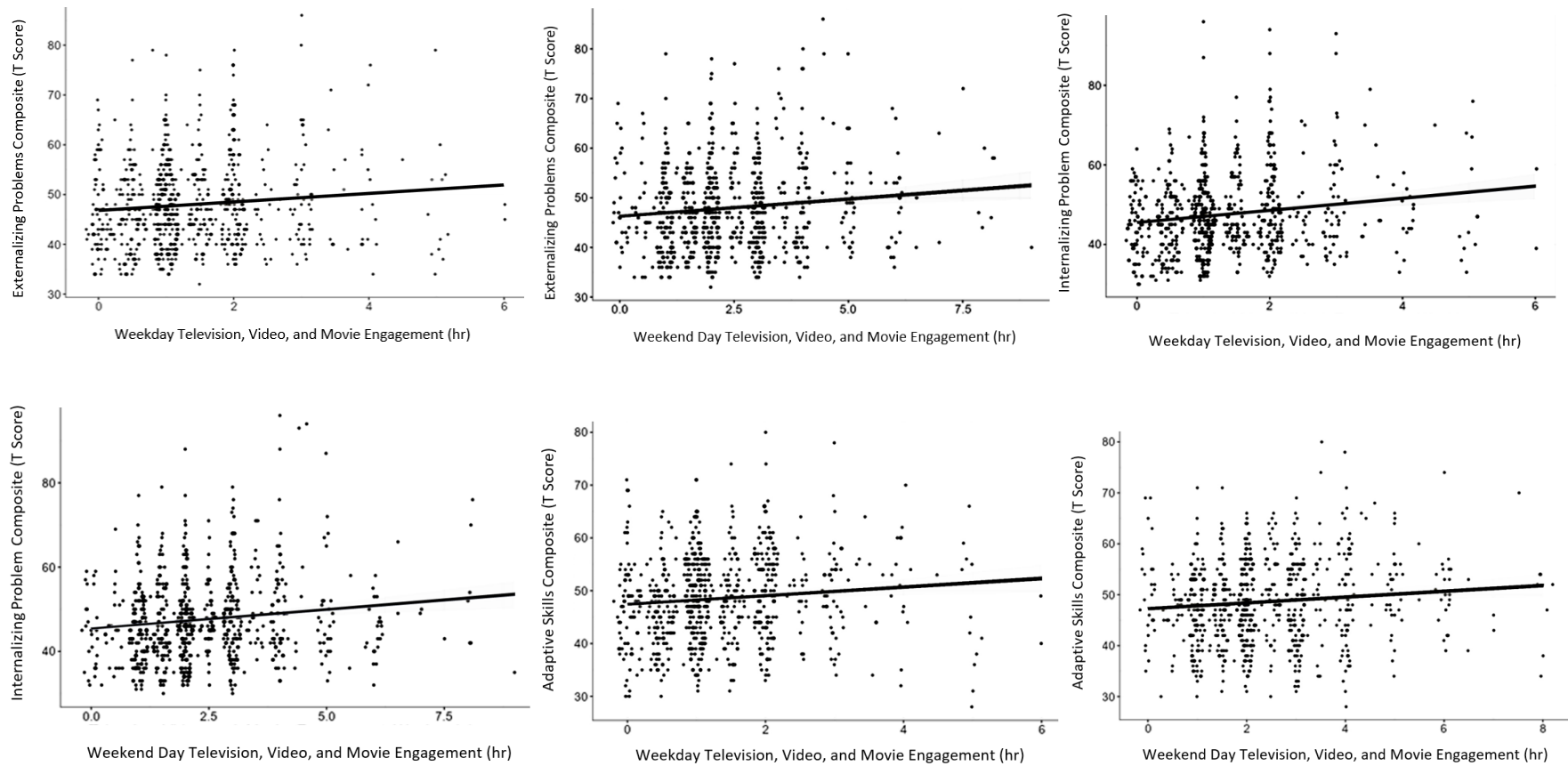
*Results of Two Linear Regression Models Calculated Below and Above Local Inflection Points Linking Parent-Reported Psychological Well-Being and Digital Technology Use*

	Inflection Point (IP; hrs)	Linear regression before IP		Linear regression after IP	
		$\beta$	$p$	$\beta$	$p$
Weekday Watching Television, Videos, and Movies					
Adaptive Composite	2.82	0.12	.30	-0.15	< .001
Internalising Composite	3.63	0.12	.54	-0.19	< .001
Weekend Day Playing Computer and Video Games					
Internalising Composite	2.91	0.10	.01	-0.11	.35

Given the limited number of analyses which reached significance, regression direction opposite to our theoretical predictions, and the linear associations explaining more variance, it did not make theoretical or practical sense to follow our original plan to investigate any curvilinear trends further. Figure 7 shows the significant linear regression analyses and provides further evidence that these associations are linear, with no clear indication of curvilinear associations.

**Figure 7**

Significant linear regressions between parent-reported psychological well-being measures and week and weekend video engagement (externalising: week,  $\beta = 0.10$ ,  $p = .007$ , weekend,  $\beta = 0.12$ ,  $p = .001$ ; internalising: week,  $\beta = 0.16$ ,  $p < .001$ , weekend,  $\beta = 0.14$ ,  $p < .001$ ; and adaptive skills: week,  $\beta = 0.10$ ,  $p = .008$ , weekend,  $\beta = 0.10$ ,  $p = .006$ ). Data is jittered.



## Exploratory Analyses

### *Additional Digital Media Variable*

Next, we examined whether there were any effects of controlling for another digital media variable in the significant linear analyses. To do this, a correlation matrix was first created to investigate the correlations between the digital media variables (For the full correlation matrix see Appendix B). The correlation matrix showed that the largest correlations were between the two video engagement variables (week and weekend) and the two digital game playing variables (week and weekend). Therefore, it was decided to adjust for the concordant week or weekend digital media variables, because these are the most different variables as defined by collinearities. For example, for weekly video engagement, weekly digital game playing was included as a covariate.

The overall pattern of results from these analyses showed that, once the concordant digital game engagement variable was adjusted for, in video engagement variable analyses these associations remained significant (Week: Externalising  $\beta = 0.10$ ,  $p = .01$ ; Internalising  $\beta = 0.16$ ,  $p < .001$ ; Adaptive  $\beta = 0.09$ ,  $p = .03$ , Weekend: Externalising  $\beta = 0.10$ ,  $p = .02$ ; Internalising  $\beta = 0.14$ ,  $p = .001$ ). On the other hand, once the concordant video engagement variable was adjusted for in digital game engagement variable analyses these analyses remained not significant (Week: Externalising  $\beta = -0.002$ ,  $p = .96$ ; Internalising  $\beta = 0.003$ ,  $p = .94$ ; Adaptive  $\beta = 0.05$ ,  $p = .24$ , Weekend: Externalising  $\beta = 0.02$ ,  $p = .64$ ; Internalising  $\beta = -0.01$ ,  $p = .91$ ). The one exception to this pattern was for the adaptive skills composite and video engagement weekend, which while adjusted for digital game engagement weekend, became not significant ( $\beta = 0.15$ ,  $p = -.06$ ). Further, the weekend digital game and adaptive

skills composite analyses remained significant once adjusting for weekend video engagement ( $\beta = -0.09, p = .03$ ).

### ***Analyses Stratified by Sex***

The final step in our analysis was to investigate whether there were differences in the associations for boys and girls by stratifying the analyses by sex. The findings of this stratification were mixed. The overall pattern of results appears to show that for watching videos in the week the analyses of girls remained significant across the psychological variables (Externalising  $\beta = 0.12, p = .019$ ; Internalising  $\beta = 0.22, p < .001$ ; Adaptive  $\beta = 0.16, p = .002$ ), while analyses with only boys were non-significant (Externalising  $\beta = 0.08, p = .16$ ; Internalising  $\beta = 0.08, p = .13$ ; Adaptive  $\beta = 0.03, p = .53$ ). However, for watching videos and playing games in the weekend analyses of boys remained significant across the psychological variables (Externalising  $\beta = 0.17, p = .003$ ; Adaptive and Videos  $\beta = 0.14, p = .01$ ; Adaptive and Games  $\beta = 0.13, p = .02$ ), with the exception of the Internalising composite (Internalising  $\beta = 0.10, p = .06$ ), while analyses with only girls were non-significant (Externalising  $\beta = 0.16, p = .07$ ; Adaptive and Videos  $\beta = 0.07, p = .21$ ; Adaptive and Games  $\beta = 0.10, p = .02$ ).

To explore whether these variations in associations were caused by differing parameters of video engagement between boys and girls, independent samples t-tests were conducted to compare boys' and girls' responses to the digital media use questions. These analyses found that boys and girls spend the same amount of time watching videos in the week (Boys:  $M = 1.41, SD = 1.06$ ; Girls:  $M = 1.40, SD = 1.08$ ),  $t(697) = .02, p = .98$ , and weekend (Boys:  $M = 2.48, SD = 1.52$ ; Girls:  $M = 2.43, SD = 1.50$ ),  $t(699) = .45, p = .65$ .

## Chapter 6: Discussion

Today's children spend a substantial and increasing amount of time using digital technology. This digital immersion has sparked widespread concern that digital device use is affecting child mental health. However, previous research in this field is limited and offers mixed results (Ferguson et al., 2021; Stiglic & Viner, 2019). A recent theory, the Digital Goldilocks Hypothesis predicts quadratic relationships may better explain the link between well-being and digital media use. The main aim of the present study was to assess whether the Digital Goldilocks Hypothesis explains the relationship between digital technology use and well-being in primary school children in Aotearoa/New Zealand. Specifically, whether a dose-response curvilinear association exists between time spent engaged with digital media and three areas of children's psychological well-being: internalising problems, externalising problems, and adaptive skills.

### **The Association between Well-being and Technology**

In contrast to predictions, the present study did not find consistent curvilinear associations between well-being and time spent using digital devices and therefore did not find support for the Digital Goldilocks Hypothesis. In addition, minimal evidence was found for linear or quadratic associations between digital game engagement and well-being, as well as between the teacher-reported well-being measures and technology use. On the other hand, the current thesis found consistent, small, positive, linear associations between video engagement and parent-reported psychological health problems. That is, children who spent more time watching videos, television, and movies had slightly higher levels of internalising, externalising, and adaptive skill problems than children who spent less time watching videos, television, and movies. These associations generally remained significant

after adjusting for a variety of potential confounds. In addition, the effect sizes for these linear associations were generally greater than the project's effect size preregistered threshold of  $\beta = 0.1$  for a small effect. Nevertheless, all observed effect sizes were reliably small and less than  $\beta = 0.2$ . Associations between the well-being subscales and digital media use were generally the same size, significance, and direction as the composite analyses.

While inconsistent with the Goldilocks hypothesis, the present findings are consistent with previous research, which has reliably found small, significant, linear associations between technology use and well-being in children (e.g., Fors & Barch, 2019; Hopf et al., 2008; Hu et al., 2020; Landhuis et al., 2007; Van Egmond-Fröhlich et al., 2012). For example, Fors & Barch (2019), Hu et al. (2020), and Van Egmond-Fröhlich et al. (2012) all conducted cross-sectional, questionnaire-based studies investigating screen time and psychological health in children. Children in these studies ranged in age from five to 11-years and sample sizes were between 579 and 11,676. These studies all found significant, linear associations between variables, with small correlation coefficients, similar in effect size to the present thesis (beta coefficients ranging from  $\beta = 0.02$  to  $0.11$ ,  $ps < .01$ ). However, it is worth noting that these studies did not assess curvilinear relations and therefore the findings are difficult to directly compare to the present results.

### **Implications**

The findings of the current study provide preliminary, but critical insight into the existence and nature of the link between well-being and screen time for children in Aotearoa/New Zealand. However, the real-world implications of our results are contingent on a range of factors including, effect size interpretation, developmental stage, causal direction, whether effects are cumulative over time, and the wider societal context. Firstly,

the study's implications are dependent on the real-world interpretation of the project's effect sizes. Consistent with previous research, the current study consistently found small effect sizes (all  $\beta$ s  $\geq 0.1$  and  $< 0.17$ ) for the significant associations between parent-reported well-being and video engagement. However, the size of the associations between video engagement time and wellbeing were reduced noticeably once control factors were adjusted for (all  $\beta$ s  $> 0.08$  and  $< 0.12$ ).

In the field of technology and well-being there has been longstanding debate about interpretation of the small effect sizes, which are commonly found. Some researchers have argued that effect size magnitudes below .2 in this field, although statistically significant, are so small that they may hold minimal practical, real-world value or clinical significance (Ferguson, 2009; Orben & Przybylski, 2019; Przybylski & Weinstein, 2017). Whereas other researchers suggest that even small effect sizes can generate large and practically meaningful effects when scaled up to the population level or when effects accumulate in magnitude over time (Funder & Ozer, 2019). However, any such effect size accumulation or population scaling would require a range of boundary conditions, including high construct validity, low measurement error and other sources of statistical noise, amongst other constraints (Sauer & Drummond, 2020). A further consideration is that a multitude of factors contribute to psychological wellbeing and therefore the effects of digital technology may sit within a large array of small, yet when combined, consequential factors, which contribute to an individual's overall psychological health (Konu et al., 2002). Therefore, it is presently unclear whether the observed small effect sizes are likely to bear real-world practical or clinical significance. Further research replicating and extending the present results in terms of their real-world implications is therefore required.

Secondly, there are several factors in this study which contribute to the potential importance of the observed small effects. For example, a small effect may have a heightened real-world impact at key developmental stages, such as in childhood. Rapid, substantial, and pivotal neurodevelopment occurs during childhood (Nelson & Gabard-Durnam, 2020), and there are widely accepted 'sensitive periods' when the brain becomes uniquely sensitive to certain exposures (Luby et al., 2020). Therefore, experiences during childhood may plausibly produce larger effects on cognition and psychological health than those of the same magnitude which occur at other developmental stages (Gee & Cohodes, 2021; Langenhof & Komdeur, 2018). Consequently, digital media use at this earlier age may also result in potentially greater accumulation of any potential negative impacts over time. We therefore highlight that longitudinal research and intervention research (e.g., interventions to systematically reduce exposure for children) should be conducted to investigate whether the observed effects are cumulative over time.

Thirdly, the current research sits amongst a wider societal backdrop of the COVID-19 pandemic. The current pandemic has resulted in worldwide digital media use reaching unprecedented levels. During lockdowns, which have been commonplace throughout the world, technology use has been amalgamated with almost all daily activities (Meissel et al., 2021). This digital device submersion has affected all age groups, including children. Technology is now used for work, education, leisure, communication, physical activity, and much more. Alongside this increased technology use, research suggests that mental health may have declined during the New Zealand lockdowns, at least for some groups (de Figueiredo et al., 2021; Gasteiger et al., 2021; Walker et al., 2021). For example, there was a significant increase in ambulance attendances for mental health conditions in Aotearoa/New Zealand during the first COVID-19 lockdown in 2020 ( $p = .005$ ; Dicker et al.,

2020). The present data was collected prior to the pandemic outbreak. Therefore, we hypothesise that any effects of digital technology on well-being may be amplified with the increased digital media use present in a pandemic environment (Hall et al., 2021).

Overall, the results of the current thesis indicate that there are linear, rather than curvilinear, associations between video engagement and child well-being. Although it is currently unclear whether these findings have a clinically meaningful impact upon children, these results, combined with their presentation within young children, during potentially sensitive developmental phases, and in the current context of the COVID-19 pandemic indicate further research is warranted. We recommend future research investigate the causal direction and clinical significance of these findings further.

### **Exploring the Goldilocks Hypothesis**

As previously discussed, the Digital Goldilocks Hypothesis predicts quadratic relationships link psychological health and screen time. Specifically, “too little” digital technology may deprive young people of social information required to connect with peers and “too much” use may displace alternate meaningful activities. Thereby, both extremes are hypothesised to negatively impact mental health. Within the theoretical framework of the Goldilocks hypothesis however, moderate use of technology may be “just right” for psychological well-being in our digitally immersed world, leading to the highest psychological wellbeing for these moderate users when compared to users at either extreme.

As mentioned previously, the results of the present thesis do not appear to support the Digital Goldilocks Hypothesis for three reasons. Firstly, analyses found only three significant curvilinear associations, out of 24 quadratic associations studied. Secondly, these

significant associations were found to be in the opposite direction to the pattern predicted by the Goldilocks Hypothesis: greater and lower levels of digital media use were linked with fewer mental health problems, while a moderate level of digital media use was linked with greater levels of mental health problems. Finally, the effect sizes for these associations were less than the study's predetermined threshold of  $\beta = 0.1$ , below which we preregistered significant results were to be interpreted with caution. Consequently, the rarity, small magnitude, and inconsistent direction of curvilinear associations in this study were not considered sufficient evidence to support the Goldilocks Hypothesis.

### ***Why have we not found evidence for the Goldilocks Hypothesis?***

Previous research has found quadratic associations linking well-being and digital media use in young people (Allahverdipour et al., 2010; Liu et al., 2016; Przybylski, et al., 2020; Przybylski & Weinstein, 2017). There are several possible explanations for why our results are not consistent with this earlier research and do not provide evidence for the Goldilocks Hypothesis in this sample of primary school children.

Firstly, the Digital Goldilocks Hypothesis may be incorrect. While several studies initially provided support for the Goldilocks Hypothesis, there is a growing body of literature which has not found evidence for this theory (Jensen et al., 2019; Johanne et al., 2021; Vuorre et al., 2021). For example, Jensen et al. (2019) and Johannes et al., (2021) examined adolescent mental health and technology. These authors used ecological momentary assessment of time spent online and using a smart phone, and objective video game play measures to assess technology use respectively. Both studies found small, positive, and negative, linear associations between variables. However, minimal evidence was found for reliable quadratic associations. Jensen et al. (2019) found only three, out of 48 curvilinear

associations studied, to be statistically significant. The effect sizes for these associations were small (all  $\beta$ s < 0.11,  $p$ s < .01), and driven by a very small number of participants, as only in the very far reaches of the distribution did the edges of the U-shaped association become substantially positive or negative. Johannes et al., (2021) used an Akaike information criterion, which is method for evaluating how well a particular model fits the data it was created from. This method revealed that the linear models were satisfactory descriptions of the associations. Therefore, both authors concluded their results provided little evidence for the Goldilocks Hypothesis. Consequently, the present study may contribute to this recent and future literature discounting the Digital Goldilocks Hypothesis.

Secondly, the lack of support for Goldilocks Hypothesis in this study may have been due to the sample's screen time not being high enough to detect this effect. The present study found significant linear, positive relations between parent-reported psychological health problems and time spent engaged with videos. However, curvilinear associations may be more pronounced for extreme users. Alternately, quadratic trends may be caused by a few high users. However, because our sample had few extreme users, we may not have had sufficient statistical power at the extremes of the scales to reveal this relationship.

Concordantly, several studies, which found evidence for the Goldilocks Hypothesis, have reported samples with greater digital device use than the present study (Allahverdipour et al., 2010; Przybylski et al., 2020; Przybylski & Weinstein, 2017). For example, Przybylski and Weinstein's (2017) landmark paper on the Goldilocks Hypothesis reported over 12 hours of total digital media engagement for 20% of their sample on weekdays and 35% on weekends. However, in the present study, none of our sample reported more than 12 hours of total use on weekdays and only 0.4% did on weekend days.

Similarly, Przybylski et al., (2020) sample of adolescents spent more time engaging with television (12.3% of sample spent 3 hours, 8.8% of sample spent more than four hours on an average weekday), than the present sample (7.4% spent 3 hours, and 4.0% spent four hours or more). In addition, Allahverdipour et al., (2010) recorded their Iranian adolescent sample spent more time playing video or computer games (6.3 hours per week), than the children in the present study (5.5 hours per week).

Two methodological differences in the calculations described above are worth noting. Firstly, Przybylski and Weinstein (2017) included two additional types of digital device use (i.e., the use of smartphones and computers, for activities other than playing games) in this calculation compared with the present study. Secondly, Przybylski et al., (2020) included video game play on a television within the television use measure, compared with the present study which instead included general video watching and movie watching as part of this measure. However, even considering these differences in media measurement, these values still suggest the present sample of New Zealand school children reported lower rates of digital media engagement than adolescents in previous studies, where Goldilocks Hypothesis was first posited.

A final possible explanation for the study findings is that children and adolescents are impacted differently by digital technology use. Previous research on the Goldilocks Hypothesis has been conducted predominantly with adolescents. The present study is one of only a few examining these associations in primary school aged children. Therefore, it is possible that curvilinear relations explain the link between well-being and screen time in adolescents. However, in younger children, the association between screen time and wellbeing may instead be linear. This difference in device-use impact, if true, may be likely

to be caused by the different psychosocial development stages of children and teenagers. For example, teenage psychosocial development is characterised by greater identification and need to conform with a peer group (Somerville, 2013; Sturdevant & Spear, 2002). Consequently, teenagers may require a moderate amount of screen use to maintain social bonds and identification within a peer group of “digital natives” and therefore, to maintain psychological health. Thereby, curvilinear relations are produced when digital media use is “too little” for teenagers to connect with their peers or “too much”, displacing other meaningful activities, both negatively impacting well-being. On the other hand, relative to adolescents, peer group conformity is a lesser psychological necessity for children (Sumter et al., 2009). Therefore, having no or very little use of digital media as a child may not substantially impact psychological well-being, thus resulting in linear relationships between well-being and screen time. This relationship may also be impacted by children’s particularly vulnerable developmental stage.

In summary, it is unclear why some researchers have found the Goldilocks Hypothesis and others, such as the present study, have not. As discussed above, there could be factors which moderate the presence of quadratic trends, such as age, magnitude of digital device use, or type device of use. However, overall, in our younger Aotearoa sample, this study suggests a simple negative linear relationship better explains the data, than curvilinear relations.

### **Digital Game Engagement and Well-being**

The present thesis found limited evidence that digital game play affects child well-being. Analyses revealed only two significant associations between digital game engagement and the psychological well-being variables, out of 12 potential links. These

significant associations comprise of one curvilinear association, discussed previously, and one linear association between adaptive skills and weekend digital game engagement. The effect sizes for these significant associations were small, at  $\beta = 0.12$  and  $0.05$ . The effect sizes for the not significant associations were very small between psychological health and digital game play, ranging between  $-.03$  and  $.07$ . The significant associations may be chance or genuine associations. However, the overall pattern of results, considering the rarity of significant findings and small effect size magnitude, demonstrates that digital game engagement did not appear to generally be related to psychological well-being for children in this study.

Although, these results differ from some published studies (Gentile et al., 2012; Hopf et al., 2008; Przybylski, 2014; Przybylski & Weinstein, 2017), they are consistent with those of Ferguson and Wang (2021), Kovess-Masfety et al., (2016), Vuorre et al. (2021), and Johannes et al., (2021). For example, in their paper Kovess-Masfety et al., (2016) investigated children's (6- 11-years old,  $n = 3,195$ ) video game play and well-being in a cross-sectional, questionnaire-based study. They found no significant associations, after adjusting for potential confounders, between time spent playing videogames and self-, parent- or teacher-reported well-being measures (odds ratio ranged from 0.23 to 1.24). When teacher and parent-report were combined, only prosocial ( $OR = 0.23, p = .02$ ) and a total difficulties score ( $OR = 0.41, p = .02$ ) were significantly associated with high videogame use. Consistent with the current study, Kovess-Masfety et al., (2016) concluded that there was no evidence for associations between video game use and any child self-reported, mother- or teacher-reported mental health problems.

A possible explanation for these results is that active digital media use may have a less negative impact on wellbeing than passive digital media use. Active screen time can be defined as engagement with screen-based activities, which are cognitively, socially, or physically reciprocal in nature, such as playing video games, or talking on social media. On the other hand, passive screen time has been defined as inactively receiving screen-based information, such as watching television, videos, or movies (Kim et al., 2020). Therefore, active digital media use may provide a platform for creativity, socializing, and physical activity (O'Hara, 2008). For example, studies show that digital games can play a critical social role for young people. In fact, online gaming handles or nicknames are one of the first pieces of information which 38% of boys share when they meet someone with who they would like to be friends (Lenhart et al., 2015). Whereas, passive digital media use may not facilitate these positive activities, and may possibly displace other beneficial activities.

Previous research supports the idea that active and passive use of digital technology effects young people's psychological health differently (Hu et al., 2021; Kim et al., 2020; Veraksa et al., 2021). For example, Kim et al. (2020) investigated depression and anxiety, and digital media use in 2,320 Canadian adolescents. These authors found that passive screen time was associated with an increased chance of meeting the diagnostic criteria for depression, social phobia, and generalized anxiety disorder. However, active screen time was not associated with meeting the criteria for any mental health diagnoses. These results are supported by other research, which has found that passive digital media use is often found to be related to poorer quality of life and other health outcomes, while active media use is not (Sanders et al., 2019). Taken together, the literature, together with the present study, suggests active screen time does not have a negative impact and may even have a positive effect on children's psychological health and development. We suggest that future

research, should not only further investigate the negative psychological effects of media, but also focus on any potential positive effects of active media use to improve connection and well-being for children.

### **Teacher-Reported Psychological Well-being**

In the present study, teacher reports of well-being were not related to digital technology use, in contrast to the previously discussed parent-reported variables. The effect sizes for the associations between teacher-reported well-being and digital media use were also smaller (below  $\beta < 0.1$ ), than the parent variable associations (ranging from  $\beta = 0.1$  to  $\beta = 0.2$ ). These differences can be explained by variation in accuracy between these reports. Two possible forms of measurement error may be affecting accuracy in this instance. Specifically, non-systematic measurement error (e.g., noise, poor reporting, poor scale quality) and systematic measurement error (e.g., systematic under or over reporting, produced by specific biases). To investigate which of these errors may be having an impact on reports, a correlation matrix examined the relations between the parent and teacher variables. These correlations varied from .23 to .33 for comparable composites, suggesting a weak correlation between these variables in our study (for the full correlation matrix see Appendix C). These weak correlations indicate that a form of non-systematic measurement error may be occurring for the teachers, causing the differences between these reports

Previous research has also found relatively poor correspondence between parent and teacher diagnostic accuracy (Lett & Kamphaus, 1997; Mitsis et al., 2000). Specifically, parents appear to have greater diagnostic accuracy for their children's psychological health problems than teachers (Ellison et al., 2016; Kahana et al., 2003). For example, Lett and Kamphaus (1997) assessed classification of children with ADHD using the BASC Teacher and

Parent report forms. This study found that parent-reported measure correctly classified 78% of ADHD cases, while the teacher-reported measure correctly classified 67% of cases (Lett & Kamphaus, 1997). In summary, non-systematic measurement error by teachers may partially explain the differential findings between the parental and teacher reports of wellbeing and media use.

## **Exploratory Analyses**

### ***Sex differences***

The current study also explored whether boys and girls experience the relationship between video engagement and psychological health differently. Analysis stratification by sex, showed that for watching videos in the week, the associations for girls remained significant across the psychological variables, while analyses with only boys was non-significant. Therefore, for girls, greater levels of video engagement were related to more psychological health problems during the week, but not for boys. However, for watching videos and playing games in the weekend, associations for boys remained significant across the psychological variables, while analyses with only girls was non-significant. Therefore, for boys, greater levels of video engagement were linked with more psychological health problems during the weekend, but not for girls.

These results could be explained by differing amounts and timings of video engagement between boys and girls. To explore this explanation further, independent samples t-tests were conducted to compare boys' and girls' parent-reported responses to the digital media use questions. These analyses found that boys and girls spend the same amount of time watching videos in the week and weekend. Consequently, it is presently

difficult to explain these results. Although it is possible these gender variations are chance findings, further research should examine potential gender differences in greater detail.

### ***Additional Digital Media Variable***

In this study we examined the impact of adding additional digital media measures to the significant linear analyses between well-being and video engagement. The overall pattern of results from these analyses showed that once the concordant digital game engagement variable was adjusted for in video engagement variable analyses these analyses remained significant (e.g., when weekend digital game play was statistically controlled for in the weekend video engagement and well-being analyses these associations remained significant). The one exception to this pattern was for the adaptive skills composite and video engagement weekend variable, which while adjusted for digital game engagement weekend, became not significant. Correspondingly, for the association between the adaptive skills composite and weekend digital game engagement, when the concordant video engagement weekend was statistically controlled for this association remained significant.

While this exception could indicate that digital game engagement is driving the associations between video engagement and adaptive skills, this also could be a chance finding. The overall pattern of results show that video engagement is more strongly associated with well-being than playing digital games. This finding is consistent with the conclusion that passive television, video, and movie watching may be negatively related to psychological health, whereas active digital media use, including digital game play, may not be associated.

## Strengths and Limitations

The present piece of research has several key strengths. Firstly, this study is one of only a few studies in this area on primary school aged children internationally and, to our knowledge, the first study of its kind in Aotearoa/New Zealand. Secondly, this study was conducted prior to the many impacts of the COVID-19 pandemic on child mental health and digital media use. Therefore, this data provides baseline data about technology use and well-being in children before the many complex impacts and influences of the pandemic on the lives of children in Aotearoa/New Zealand. Thirdly, multiple measurement and analyses tools were utilised to increase validity of study results. These included pre-registering the current study and the adjustment for a wide variety of relevant control variables in analyses. In addition, our measure of psychological well-being, the BASC-2, is a valid and reliable tool, and is more comprehensive than many questionnaires use in previous studies, such as the Strengths and Difficulties Questionnaire (Reynolds & Kamphaus, 2004). The consistency of the BASC-2 subscale analyses with the composite analyses also provides supportive evidence that the BASC-2 is a valid tool to measure child psychological health.

However, the results of the present study also need to be considered in light of a number of limitations. Firstly, the data analysed in the present research were cross-sectional in nature. Therefore, there are multiple potential causal explanations for the current findings. Specifically, our results could indicate that children who experience greater psychological health difficulties are also more likely to passively watch videos, movies, and television. For example, video engagement could be used as a coping mechanism to avoid challenging emotions. Alternatively, watching videos may produce greater levels of psychological problems by displacing other, psychologically beneficial activities. Further,

both of these explanations may be and occurring simultaneously and bidirectionally. Equally likely, there might be factors which affect both digital media engagement time and well-being. For example, children who grow up in homes with high incomes may be more likely to be healthier and more likely to be able to afford to engage in a range of leisure activities and classes, producing less total time to be spent in digital activities, than for children from low socioeconomic backgrounds.

Secondly, both the well-being and screen time measures were provided by single time point parent- or teacher-report. For screen use, the current study used global time estimates, which are questions asking individuals for one total exposure value for media use (e.g., “On an average weekday, about how much time does your child spend watching television?”; Vandewater & Lee, 2009). While global time estimates are common in this research field, they have been criticised for their low correlations with objective and time diary measures of screen time (correlation coefficients ranging from around .20 to .40; Vandewater & Lee, 2009). Therefore, it has been recommended that measures with greater accuracy and less potential bias are used (Kaye et al., 2020). On the other hand, other researchers have suggested that for descriptive purposes, global estimates may provide a sufficient indication of trends across a population (Vandewater & Lee, 2009). Overall, a potential limitation of the screen time measures in the current project is their possible lower validity compared with other types of digital media use measures.

Thirdly, some groups were underrepresented in the present sample. The majority of participants reported New Zealand European ethnicity and Māori and other ethnic groups were underrepresented. This underrepresentation limits the generalizability of the study findings to the wider population of Aotearoa/New Zealand. It also constrains the ability of

this research to meaningfully explore this data for a variety of ethnic groups, including Māori. Further, the overall study response rate is 16%, which is relatively low. This response rate is limitation because it may have produced sample biases and limit external validity.

Despite these limitations, the study has some important implications.

## **Conclusion**

In summary, the expansion of digital technology has caused widespread concern that device use has the potential to negatively impact child health. The current study has explored the relationship between digital technology and primary school aged children's psychological well-being. Results indicate there may be a positive, linear association between passive media consumption and greater psychological health problems. Results also suggest active video game play and child well-being may not bear any association to psychological health. Little evidence was found for curvilinear trends predicted by the Digital Goldilocks Hypothesis. The findings have added to the existing literature and provided more information about the relationship between technology and psychological health an under researched group, of primary school aged children. The clinical and practical implications of these results for the digital media use by New Zealand children are complex, and their interpretation is dependent several factors. Future research is required to investigate if results are replicable, and whether these results are consistent across countries, cultures, schools, and other environments. Further examination and longitudinal research are required to understand the causal nature of the data.

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## Appendix A

**Table A1** Results of Significant Linear Regression Models Linking Psychological Well-Being Subscales and Digital Technology Without Adjustments for the Control Variables

		$\beta$	SE	95% CI	$p$
Watching Television, Videos, and Movies					
Externalising Composite	Hyperactivity				
	Week	<b>0.12</b>	0.34	[0.47, 0.20]	<b>0.001</b>
	Weekend	<b>0.15</b>	0.24	[0.08, 0.22]	<b>&lt;0.001</b>
	Aggression				
	Week	0.06	0.31	[-0.01, 0.14]	0.104
	Weekend	0.07	0.22	[-0.01, 0.14]	0.08
Conduct	Week	0.08	0.32	[0.01, 0.16]	<b>0.03</b>
	Weekend	0.09	0.23	[0.02, 0.17]	<b>0.02</b>
Internalising Composite	Anxiety				
	Week	0.09	0.38	[0.01, 0.16]	<b>0.02</b>
	Weekend	0.08	0.27	[0.003, 0.15]	<b>0.04</b>
	Depression				
	Week	<b>0.13</b>	0.33	[0.51, 0.20]	<b>0.001</b>
	Weekend	<b>0.13</b>	0.23	[0.05, 0.20]	<b>&lt;0.001</b>
Somatization	Week	<b>0.18</b>	0.36	[0.11, 0.26]	<b>&lt;0.001</b>
	Weekend	<b>0.13</b>	0.26	[0.06, 0.21]	<b>&lt;0.001</b>
Adaptive Skills Composite	Adaptability				
	Week	<b>0.12</b>	0.33	[0.05, 0.20]	<b>0.001</b>
	Weekend	0.09	0.23	[0.02, 0.16]	<b>0.02</b>
	Social Skills				
	Week	0.01	0.33	[-0.07, 0.08]	0.85
	Weekend	0.004	0.23	[-0.08, 0.07]	0.92
	Leadership				
	Week	0.05	0.31	[-0.03, 0.12]	0.20
	Weekend	0.08	0.22	[0.01, 0.16]	<b>0.03</b>
	Activities of Daily Living				
Week	<b>0.15</b>	0.32	[0.07, 0.22]	<b>&lt;0.001</b>	
Weekend	<b>0.16</b>	0.23	[0.09, 0.24]	<b>&lt;0.001</b>	
Functional Communication	Week	0.08	0.32	[0.01, 0.16]	<b>0.04</b>
	Weekend	<b>0.10</b>	0.22	[0.02, 0.17]	<b>0.01</b>
Playing Computer and Video games					
Adaptive Skills Composite	Adaptability				
	Weekend	<b>0.11</b>	0.30	[0.03, 0.18]	<b>0.005</b>
	Social Skills				
	Weekend	0.05	0.30	[-0.03, 0.12]	0.21
	Leadership				
	Weekend	0.08	0.28	[0.01, 0.16]	0.03
Activities of Daily Living					
Weekend	<b>0.16</b>	0.29	[0.08, 0.23]	<b>&lt;0.001</b>	
Functional Communication					
Weekend	<b>0.10</b>	0.29	[0.02, 0.17]	<b>0.01</b>	

Note: Quadratic relations were tested while controlling for linear relations. CI = confidence interval. Bolded level of significance  $p < 0.05$  and effect size  $\beta \geq 0.1$ .

## Appendix B

**Table A2**

*Correlation Matrix of Digital Media Use Variables*

		Video Engagement Week	Video Engagement Weekend	Digital Game Play Week	Digital Game Play Weekend
Video Engagement Week	Pearson's r	—			
	p-value	—			
Video Engagement Weekend	Pearson's r	0.569	—		
	p-value	< .001	—		
Digital Game Play Week	Pearson's r	0.265	0.254	—	
	p-value	< .001	< .001	—	
Digital Game Play Weekend	Pearson's r	0.293	0.431	0.650	—
	p-value	< .001	< .001	< .001	—

### Appendix C

**Table A3**

*Correlation Matrix between Teacher and Parent Reported BASC-2 Psychological Well-being Composites*

		Teacher Externalising Composite	Teacher Internalising Composite	Teacher Adaptive Skills Composite	Parent Externalising Composite	Parent Internalising Composite	Parent Adaptive Skills Composite
Teacher Externalising Composite	Pearson's r	—					
	p-value	—					
Teacher Internalising Composite	Pearson's r	0.237	—				
	p-value	< .001	—				
Teacher Adaptive Skills Composite	Pearson's r	-0.539	-0.475	—			
	p-value	< .001	< .001	—			
Parent Externalising Composite	Pearson's r	<b>0.331</b>	-0.033	-0.134	—		
	p-value	< .001	0.646	0.060	—		
Parent Internalising Composite	Pearson's r	-0.015	<b>0.300</b>	-0.111	0.430	—	
	p-value	0.839	< .001	0.121	< .001	—	
Parent Adaptive Skills Composite	Pearson's r	-0.219	-0.089	<b>0.276</b>	-0.600	-0.454	—
	p-value	0.002	0.214	< .001	< .001	< .001	—