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Preschoolers' engagement with screen content and associations with sleep and cognitive development☆

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ABSTRACT

Preschool children's exposure to screen media and associations with sleep, language, and cognition were investigated along with the time of day of screen exposure, content type, and whether use occurred with someone. Caregivers of Australian children, aged 2 years, 11 months to 5 years, 11 months, answered questions online about the durations children engaged with entertainment, relaxing/calming, and educational content. Fifty-nine percent of children engaged with relaxing/calming content and 86 % with educational, but all children engaged with entertainment content, which became the focus of the analyses. Average daily durations engaged with relaxing and educational content were 1 h each and 2 h for entertainment content. Longer time spent engaged with entertainment content was associated with shorter sleep duration and poorer sleep quality. The interaction between screen time and usage at night vs. daytime only was non-significant suggesting that the association with sleep duration was similar regardless of time of day of usage. Greater screen time also predicted lower communication and problem solving scores, and more attention difficulties. Engaging in screen content with someone else was associated with poorer problem solving skills, whereas engaging alone was associated with better problem solving. The findings here indicate that preschoolers largely engage in entertainment content and this has implications for their sleep even when screen engagement predominantly occurs during the day. Greater screen time also has implications for cognitive and language development raising questions about the time children spend on screens that could be spent on activities that better support development.

1. Introduction

Children's accessibility to and consumption of media devices (e.g., smart phones, tablets, computers, televisions) has increased over the past decade (Ribner & McHarg, 2021; Rideout, 2021; Yu & Baxter, 2016), and in Australia, children as young as 4 own their own device (Graham & Sahlberg, 2021). The World Health Organization (2019) and Australian Department of Health (health.gov.au, 2021) recommend no screen time for children under the age of 2 and no more than one hour for children aged 2 to 4 years. However, 75 % of Australian preschoolers exceed these recommendations (Hinkley et al., 2020). As children's close, regular and prolonged exposure to screens is a relatively new factor in human history, it is important to understand any associations with sleep and development. There are reports of positive, neutral, and negative associations with sleep and development, indicating that the effects of screen time are not uniform (Jusienė et al., 2020; Tomopoulos et al., 2010; Yland et al., 2015). Walsh et al. (2018) found that school children who met the recommended guidelines for screen time, sleep, and physical activity performed better on cognitive measures. It is therefore important to also consider sleep in investigations of screen time and associations with developmental outcomes. The mixed findings in the literature could be due to the time of day (e.g., exposure at night),

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the type of content, and the way screen media is used (with someone or alone). Therefore, a detailed approach to investigating screen time, sleep and development is required.

1.1. Screen media usage and sleep

Sufficient and good quality sleep contribute to our ability to function in everyday life (Walker & Stickgold, 2006), and is also important for child neural development (Hill et al., 2007; Jiang, 2019), learning and memory (Axelsson et al., 2016; Mason et al., 2021). A review by Janssen et al. (2020) found that increased screen media use was associated with shorter sleep duration, more night awakenings, later bedtimes, and poorer sleep quality in infants and toddlers, but that the research with preschoolers was weak. Ribner and McHarg (2019) found that greater screen time at 4 months of age was associated with shorter nocturnal sleep at 10 and 14 months. Greater screen time at 4 years of age also predicted poorer sleep at 6 and 8 years; and poorer sleep also predicted greater screen time (Magee et al., 2014). One possible explanation for these findings is that poor sleep leads to less physical activity and more sedentary behavior (such as screen time behavior), which in turn reduces the homeostatic drive for sleep. Shorter sleep durations and poorer sleep quality are predictors of poorer scores on later measures of cognition, language, and behavioral development (Scher, 2005; Tikotzky et al., 2010; Touchette et al., 2007). Therefore, investigations into the association between screen time and development need to account for sleep.

Sleep is affected by psychological, biochemical, genetic, and external factors such as light; and nighttime light exposure can disrupt sleep-wake cycles (Blume et al., 2019; Hill, 2011). The time of day children are exposed to screens could be important for sleep, particularly when it occurs prior to nocturnal sleep. Preschoolers' greater engagement with TV at night and use of screen devices at bedtime is associated with shorter sleep duration (Lo et al., 2021; Nathanson & Fries, 2014), and later sleep onset (Cheung et al., 2017; Falbe et al., 2015; Sijtsma et al., 2015; Twenge et al., 2019). Exposure to light, in particular blue light, can suppress melatonin levels and disrupt circadian rhythms (Akacem et al., 2018; Aubé et al., 2013; Brainard et al., 2001; Oh et al., 2015; von Gall, 2022). Nighttime use, at a time when children could be in the process of falling asleep, could also lead to greater arousal if there is cognitive engagement with screen content (Cheung et al., 2017; Janssen et al., 2020). However, Cheung et al. (2017) found that touchscreen use did not predict night awakenings in infants and toddlers. In contrast, Bellagamba et al. (2021) found that time spent in shared book reading was associated with longer sleep durations. The evidence so far indicates that screen exposure particularly before bed could reduce sleep duration, but there are calls for more evidence with preschoolers (Janssen et al., 2020).

1.2. Screen media usage and development

Children's early years are a period of rapid cognitive and language development (Fernald & Weisleder, 2015; Hart & Risley, 1995; Mahr & Edwards, 2018), and the evidence surrounding the effects of screen time are mixed.

1.2.1. Cognitive development

Exposure to screens for at least an hour per day is associated with lower scores on cognitive tasks among infants and preschoolers (Lin et al., 2015; Schwarzer et al., 2022; Tomopoulos et al., 2010). Tamana et al. (2019) found that greater screen time in preschoolers was associated with greater attention difficulties as measured by the Child Behavior Checklist (Achenbach & Rescorla, 2000). Greater screen time at 4 months of age was associated with poorer cognitive inhibitory control at 10 and 14 months, but not working memory or cognitive flexibility (McHarg et al., 2020). Corkin et al. (2021) found that TV viewing at age 2 and 4 was associated with poorer inhibitory control and working memory at 4 and 4.5 years. In contrast, a systematic review by Jusienė et al. (2020) revealed that preschoolers' screen time did not predict working memory, inhibitory control or nonverbal/abstract reasoning. McBee et al. (2021) revisited previous analyses of early screen time and later attention problems and argued that the results are not as robust as previously thought. They also argued that many studies are primed to find negative effects of screen time. Portugal et al. (2021) found that toddlers with high screen times had faster visual search times than low users suggesting that screen use supports attentional focus. Screen content could play a role. Courage et al. (2021) found that toddlers' cognitive skills improved with the use of educational applications and that they paid more attention and acquired more storybook content than they did from paper books. However, complex, cognitively challenging, and salient content presented at a rapid pace can have diminishing effects on preschoolers' attention and could lead to a reliance on bottom-up processing (Essex et al., 2022; Geist & Gibson, 2000).

1.2.2. Language development

Tomopoulos et al. (2010) found that greater screen time at 4 months predicted poorer scores on language measures at 14 months (see also Lin et al., 2015). The type of content might also matter for language as less engaging/interactive TV content is associated with poorer language development in toddlers and more interactive content with positive associations (Linebarger & Walker, 2005). Barr et al. (2010) found that early exposure to adult-directed content predicted poorer scores on cognitive measures at 4 years of age, but no significant associations were seen with child-directed content. Conversely, Duch et al. (2013) found that >2 h of daily screen time was associated with poorer scores on the communication sub-scale of the Ages and Stages Questionnaire (ASQ; see also Byeon & Hong, 2015); and this was with child-directed and educational content, but not with adult-directed content. Alloway et al. (2014) found that screen content had little influence on 3-year-old children's vocabulary, but that time listening to stories was a stronger predictor. Background TV during parent-infant play is associated with less speech and a reduced diversity of words among parents, which in turn was associated with poorer vocabulary sizes in 17-month-old toddlers (Masur et al., 2016).

1.3. Screen media usage, content, sleep, and development

There are few known studies that have investigated screen time along with sleep and their associations with language and cognitive development. Nathanson and Beyens (2018) found that greater screen time in the evening predicted poorer effortful cognitive control in preschoolers, but that this was moderated by sleep duration, with shorter sleep associated with poorer outcomes. Therefore, it is important to account for exposure to screens at night. Screen content and the way in which children engage with screens are also important to consider (Sweetser et al., 2012), as screen time could be physiologically inducing children to remain awake (Hale et al., 2018). Yland et al. (2015) found that >2 h a day of engagement with TV and computers, but not with video games, was associated with poorer sleep in school children. Whether usage occurs with someone else could also be important. Shah et al. (2021) found that greater conversation between caregivers and their children during screen time was associated with greater levels of curiosity, and this was particularly the case for children from lower socioeconomic backgrounds.

The present study aimed to investigate preschoolers' exposure to three different types of content (relaxing/calming, entertainment, and educational) and explore associations between time spent engaged with the different content types and a) sleep duration and quality and b) cognitive and language development. Relaxing/calming content is content that is created to have a relaxing effect and/or is content that is typically presented at a slower, less cognitively demanding pace (c.f., Essex et al., 2022; Geist & Gibson, 2000). Asking caregivers about engagement durations with relaxing content was aimed at determining if it would have a weaker association with poor sleep and cognitive performance. Entertainment content is content that typically holds children's attention and tends to be fast-paced and engaging, but could be associated with more bottom-up processing (e.g., Essex et al., 2022). Durations of time children spend on entertainment content could be associated with increased physiological arousal and poorer sleep (e.g., Hale et al., 2018). Educational content is content that is aimed at promoting children's learning, and might be associated with greater cognitive and language performance, but could also be physiologically arousing and less conducive to good quality sleep. Caregivers of Australian 3- to 5-year-old children completed online questionnaires on their child's screen time durations during the day and at night. This data was aimed at guiding future studies using empirical measures of language and cognition and objective measures of sleep. Importantly, we considered whether screen exposure typically occurred at night as well as the type of engagement with screens (with someone vs. alone). It was predicted that longer time engaged with entertainment content, particularly at night, would be associated with shorter and poorer quality sleep. It was expected that relaxing content would have a weaker association with sleep. Longer screen times and usage that typically occurs on the child's own were expected to be associated with poorer cognitive and language outcomes.

2. Method

2.1. Design

This was an online cross-sectional survey with a correlational design. Data collection occurred from 16 September 2021 to 21 February 2022.

2.2. Participants

A power analysis using G*Power (Faul et al., 2007) revealed that the largest analysis involving 5 predictors, and a medium effect size ($f^2 = 0.15$, power = 0.80, alpha = 0.05), would require 92 participants. The age range of interest was 3 to 5 years and the specific age range suitable for the Ages and Stages Questionnaire-3 (ASQ-3) is 2 years 10 months to 5 years, 6 months (ASQ see Table 1). Data came from 106 caregivers of typically developing children (*M* age = 4 years, 3 months, 10 days; *SD* = 9 months, 14 days; range: 2 years, 10 months, 27 days to 5 years, 11 months, 5 days). The questionnaire was completed in its entirety by 95 participants. As some segments of the questionnaire were incomplete for some participants, the number of participants for each variable differs (see Table 4). Seven children who were older than 5 years, 6 months were excluded from the analyses involving the ASQ-3. Any children diagnosed with a neurological or learning condition were also excluded. All of the caregivers (*M* age = 36.58 years, *SD* = 4.83) who completed the questionnaire identified as the mother aside from 2 who identified as the father. As responses could be influenced by geographical location (e.g., Bellagamba et al., 2021), participants were required to reside in Australia to take part. Parents described their ethnicities as Australian (76 %), European (8 %), Asian (8 %), Australian-European (4 %), Australian-Asian (1 %), New Zealander (1 %), Maori New Zealander (1 %), and North American (1 %). All caregivers lived with their child 7 days per week and could report on their child's behaviours across the entire week.

Table 1
Age ranges for the Ages and Stages Questionnaire-3.

Questionnaire	Age range		Subscales completed *n*
	From	To	
36-month	34 m, 16d	38 m, 30d	12 (communication)
	(2y, 10 m, 16d)	(3y, 2 m, 30d)	10 (problem solving)
42-month	39 m, 0d	44 m, 30d	22 (communication)
	(3y, 3 m)	(3y, 8 m, 30d)	22 (problem solving)
48-month	45 m, 0d	50 m, 30d	15 (communication)
	(3y, 9 m)	(4y, 2 m, 30d)	14 (problem solving)
54-month	51 m, 0d	56 m, 30d	20 (communication)
	(4y, 3 m)	(4y, 8 m, 30d)	20 (problem solving)
60-month	57 m, 0d	66 m, 0d	25 (communication)
	(4y, 9 m)	(5y, 6 m)	25 (problem solving)

2.3. Materials

2.3.1. Questionnaire platform

The questionnaires were generated and presented online using Qualtrics software (Qualtrics, 2021).

2.3.2. Sociodemographic questions

Caregivers were asked for the child's date of birth, health history, number of siblings, and any learning or developmental issues. Caregivers' also provided their age, education level, number of years in education, and ethnicity.

2.3.3. Screen time questions

The questionnaire was split into the following segments: child access to screen media, screen media content type durations, time of day of usage, whether usage was with someone or alone.

2.3.4. Child's access to screen media

These questions were aimed at determining the types of media devices this age range are using and the frequency. The questions were adapted from a report published by Common Sense Media (Rideout, 2021) and from SCREENS-Q (Klakk et al., 2020), a validated questionnaire with moderate to high test-retest reliability (intra-class correlations (ICCs): 0.67–0.90) and moderate internal consistency (ρ = 0.59–0.66). The questions focussed on the types of screen media devices that were present in the household (e.g., laptop, desktop computer, tablet/iPad/surface, smartphones, TV, gaming console, handheld gaming console, e-reader), and how often they had used them in the past month with the following options: 'every day or almost every day of the week', '4-5 days a week', '2-3 days a week', '1 day or less a week', 'never', 'not applicable'. They were also asked the frequency with which they used more than one device at a time, such as using a tablet while watching TV with the options: never, rarely, sometimes, often, always.

2.3.5. Screen media content type durations

Questions were adapted from SCREENS-Q (Klakk et al., 2020) and Ribner and McHarg (2019). Caregivers were asked about their child's engagement with three different types of content to assess whether content type is associated with different outcomes: entertainment, relaxing/calming, educational/learning. These are broad categories of content that are presumably created to have either an entertaining, relaxing/calming, or educational effect, and might have differential associations with sleep, cognition, and language. The content types were presented in a counter-balanced order to limit any demand characteristics from influencing responses (e.g., educational content could be perceived as more desirable than entertainment). Each content type was presented with a list of typical categories. The specific question for entertainment content was (for example), "*How much time does the child spend on ENTERTAINMENT screen media during a typical WEEKDAY? For example, watching movies or TV shows, watching YouTube videos, playing games, using social media, or video calling.*" Examples options for entertainment content were: *'entertaining movies/TV shows (DVDs, streaming services)', 'entertaining YouTube videos', 'entertaining games (e.g., Roblox, Among Us, Candy Crush)', 'social media (e.g., Kids' Messenger)', 'video calling (e.g., Skype)'*. Caregivers could also add other examples. The same question was presented for relaxing/calming content with the following examples: *'calming movies/TV shows (DVDs, streaming services)', 'storybook apps', 'meditation/mindfulness', 'calming YouTube videos (e.g., get ready for bed routines, yoga for kids)', and 'listening to calming music'*. The same question was applied to educational/learning content with these examples: '*documentaries/how-to videos', 'creative programs (e.g., art or music apps)', 'learning apps (e.g., number/vocabulary/language general knowledge)', 'information searching (e.g., species of animals)', 'writing/drawing/painting', 'taking photos/fil*ming'. When it came to durations of engagement, caregivers could choose from the following time intervals for each category of a given content type: 1–29 min, 30–59 min, 1–2 h, 2–3 h, 3–4 h, 4–5 h, 5 h. To create a single screen time duration for each content type, we followed the same method as Klakk et al. (2020) and Pedersen et al. (2022): the median value of the ranges (e.g., 1–29 min = 15 min; 30–59 = 45 min) were assigned as the durations for each category. These values were summed across the categories in each content type for weekdays and weekends. To average across weekdays and weekends, we used the same formula as Klakk et al. (2020): (total on a weekday × 5) + (total on a day on the weekend × 2)/7.

2.3.6. Time of day (at night or not)

Caregivers were also asked to select durations of time spent (1–15 min, 15–30 min, 30–45 min, 45–60 min, 1–1.5 h, 1.5–2 h, 2–2.5 h, 2.5–3 h, 3–4 h, 4–5 h, 5 h or more) on content types at differing times of the day on weekdays: before school, after school but before dinner, after dinner but before bed, immediately before bed; and on weekends: before 12 p.m., after 12 p.m. but before dinner, after dinner but before bed, immediately before bed. In particular, we were interested in whether engagement occurred at night or not. The average time that children were reported to start bedtime routines was 6:48 pm and the average time they were reported to fall asleep was 7:48 pm (see sleep duration subsection below). Therefore, with what is likely a short time frame between dinner time and bedtime, we aggregated the children who were reported to engage with screens after dinner and those who engaged before bed. A categorical variable was created: if caregivers selected one of the durations 'after dinner but before bed' or 'immediately before bed' on weekdays and weekends, then this was categorised as 'yes' for engagement at night.

2.3.7. With someone or alone

To assess whether usage occurred with someone or on their own, caregivers were asked whether their child tended to engage in a category type the majority of the time: 'with a caregiver or adult', 'with another child', 'alone', or 'does not do this type of activity'. A single categorical variable was created based on whether they tended to engage with someone or alone. For a given content type (e.g., entertainment), if they engaged in most of the categories (e.g., movies/TV, YouTube etc.) with someone, they were classified as predominantly engaging in content with someone. If there was an equal number of categories with a viewing type (e.g., 3 categories engaged with someone, 3 categories alone), durations of engagement were looked at to see which viewing type was associated with the longest durations.

2.3.8. Sleep duration

Caregivers were asked: the time their child's bedtime routine began, bedtimes, times they typically fell asleep, times they typically awoke in the morning, and times they got out of bed in the morning. The questions were aimed at calculating an estimate of sleep duration, which was the time from falling asleep to the time the child awoke in the morning. Caregivers were asked these questions for weekdays and weekends and nocturnal sleep durations were averaged across weekdays and weekends.

2.3.9. Children's Sleep Wake Scale (CSWS; LeBourgeois & Harsh, 2016)

This 25-item standardised tool assesses sleep quality in 2- to 8-year-old children. Items cover a broad range of behaviours surrounding bedtimes, falling asleep, maintaining sleep, and getting out of bed. Caregivers rate the frequency of the behaviours on a 6-point scale (never, once in a while, sometimes, quite often, frequently-if not always, and always). The tool provides a total score and scores on the following subscales: Going to Bed, Falling Asleep, Maintaining Sleep, Reinitiating Sleep, Returning to Wakefulness. Example items include, '*When it's time to go to sleep (lights out), your child has trouble settling down.' 'During the night, your child awakens more than once.' 'After arousing or awakening, your child rolls over and goes back to sleep.'* Lower scores are associated with poorer sleep quality. Internal consistency reliability between the subscales and the total score is excellent (Cronbach's $\alpha = 0.81$–0.91), and test-retest reliability coefficients are moderate to strong ($r = 0.67$–0.84). Correlations with caregiver diary ratings are moderate-to-strong ($r = 0.58$–0.72), and they are weak-to-moderate with sleep quality measured by actigraphy ($r = 0.38$–0.61). It is also effective in distinguishing children who are 'good sleepers' (scores above 5), those with behavior problems (scores below 5), and those with sleep onset issues (scores below 4).

2.3.10. The Ages and Stages Questionnaire-3 (ASQ-3; Squires et al., 2009)

This is a brief, standardised screening tool suitable for children aged 2 to 60 months. It was chosen for its brevity, but also because it provides scores on five developmental domains: communication, gross motor, fine motor, problem solving, and personal-social. The focus in the current study was on the communication and problem solving domains to assess language and cognitive development. Caregivers responded on a three-point scale (yes = 10, sometimes = 5, not yet = 0) to six questions in each developmental domain. An example item from the communication domain is, *'When looking at a picture book, does your child tell you what is happening or what action is taking place in the picture (for example, "barking", "running", "eating", or "crying")? You may ask, "What is the dog (or boy) doing?"* An example from the problem solving domain involves showing the child three circles of varying size. '*When asked, "Which circle is the smallest?" does your child point to the smallest circle? (Ask this question without providing help by pointing gesturing, or looking at the smallest circle.)* Domain scores can indicate whether development is on schedule, the child should be provided with additional activities and monitored (scores below 40 for communication and problem solving), or the child may require further assessment (scores below 25–30). Questionnaires differ depending on the specific age range. Five questionnaires fit the ages of the target population (3- to 5-year-olds) of this study (see Table 1). Internal consistency for this questionnaire ranges from moderate to excellent (Cronbach's $\alpha = 0.51$–0.87). Test-retest reliability is very good (ICCs = 0.75–0.82), inter-rater reliability is moderate (ICCs = 0.43–0.69), and concurrent validity is high with correct classification of 92 % of typically developing 42- to 60-month-old children (Squires et al., 2009; Rubio-Codina et al., 2016; Marks & Larosa, 2012).

2.3.11. Child Behavior Checklist (CBCL) 1.5–5 (Achenbach & Rescorla, 2000)

This is a 99-item standardised questionnaire suitable for 1.5- to 5-year-old children. Caregivers rated items on a 3-point scale in terms of how true the statements were of their child (not true, somewhat or sometimes true, very true or often true). The CBCL provides a total score and scores on 7 sub-scales: Emotionally Reactive, Anxious/Depressed, Somatic Complaints, Withdrawn, Sleep Problems, Attention Problems, Aggressive Behavior, and Other. Internal consistency scores are very good ($rs > 0.86$), test-retest scores range between $r = 0.68$–0.85, and cross informant agreement is moderate ($r = 0.61$). Norms for the subscales can be classified as normal, borderline (93rd–97th percentiles), and within clinical ranges (scores above the 97th percentile). The focus in the current study was on Attention Problems due to the findings of Tamana et al. (2019) that preschoolers' greater screen time was associated with greater difficulties with this subscale. Example items include, '*Can't concentrate, can't pay attention for long', 'Quickly shifts from one activity to another'*.

2.3.12. Attention check questions

These were included in the parts of the questionnaire with the most dense sets of questions (e.g., 99 questions of the CBCL). Examples were:

"*What season are you completing these questions in? (summer, autumn, winter, spring)*"; "*I am living in the southern hemisphere (yes, no)*". "*Is the sky always the colour blue?*"

2.4. Procedure

This study was ethically approved by the first authors' university Human Research Ethics Committee (Approval No. H-2021-0216). Participants were recruited via social media (Facebook). Participants were first screened for their suitability for the study and were invited to take part if they lived in Australia, the child was within the age range of interest, the child had not been diagnosed with any neurodevelopmental or mental health disorders. Initial consent to be contacted about the experiment was obtained by caregivers who expressed interest via email or via the relevant social media pages. A record of informed consent was obtained from caregivers prior to commencing the online questionnaires. Caregivers were informed that they did not need to complete the questionnaire in one setting. Participants received a $20 e-gift voucher from booktopia.com.au upon completion.

It is important to note that from the beginning of data collection, 16 September, to the end of October 2021, Australia was in partial lockdown due to the COVID-19 pandemic. This meant that children likely did not attend childcare/preschool during that period. The questionnaire was created prior to lockdown. Socialising (in limited numbers) and outings (e.g., outdoor exercise, picnics, visits to parks, beaches etc.) were permitted so outdoor activities were still possible.

The median questionnaire completion duration was 48.48 min. As some did not need to complete the questionnaire in one sitting, the range was wide (18.62–8938.48 min; $M = 802.61$; SD: 1702.17). The majority took <2 h (66 %) and the median completion time for these participants was 33.95 min (18.62–93.20 min; $M = 39.79$; $SD = 16.81$).

2.5. Analyses

Using jamovi 1.6.23 software, children's access to screen media and the engagement durations with the content types were explored. The data were then analysed with hierarchical multiple regression models. The first set of analyses focused on the dependent variables (DVs) surrounding sleep: sleep duration, and sleep quality as measured by the CSWS. The predictor variables for each analysis were child age, caregiver years in education, average screen exposure durations, whether viewing occurred at night or not, and the interaction between screen durations and whether it occurred at night or not. We included child age to account for the potential effect of development associated with the key variables and caregiver years in education to attempt to account for caregiver factors as they can play a role (e.g., Reus & Mosley, 2018).

The second set of analyses focused on the dependent variables surrounding language and cognitive developmental outcomes. The communication subscale and the problem solving subscale of the ASQ-3 were used as measures of language and cognition, and the attention problems subscale of the CBCL was another measure of cognition. The predictors were average screen exposure duration, sleep duration, whether children predominantly engaged in screens with someone or alone, and the interaction between screen exposure duration and whether it occurred with someone or alone. The aim was to conduct all these analyses with the three different types of content separately: entertainment, relaxing/calming, and educational.

3. Results

3.1. Descriptives

3.1.1. Child access to screen media

Almost all households had a laptop, tablet, smartphone and TV and a large proportion (75 %) had a gaming console (see Table 2). The majority of children in this sample did not own their own device, but nearly a quarter of the sample owned their own tablet. A large proportion (74 %) watched television at least 4 to 5 days per week and used a tablet (76 %) or smart phone (71 %) at least 2 to 3 days per week (see Table 2). Caregivers also reported that none of the children always used more than device at time, but 1 % did this often, 19.61 % rarely or sometimes, and 79.41 % never used more than one device at a time.

3.1.2. Engagement durations for each content type

The raw durations (minutes) for each of the categories in each content type (entertainment, relaxing/calming, educational) on weekdays and weekends were averaged across participants (see Figs. 1-3 for durations averaged across weekdays and weekends). It became apparent that all children engaged in entertainment content. However, only some engaged in relaxing/calming or educational content, and of the ones who did, the durations were relatively short. There were also extreme outliers for the durations (see Figs. 1-3). For the analyses, the totals for each content type, averaged across weekdays and weekends, were calculated for those who engaged in the given content type (>0 min) and the outliers were replaced by the content type mean (see Table 3). Given that all children engaged in entertainment content, this variable was the focus of subsequent analyses. However, the analyses for the relaxing/calming and educational content were still performed and are presented

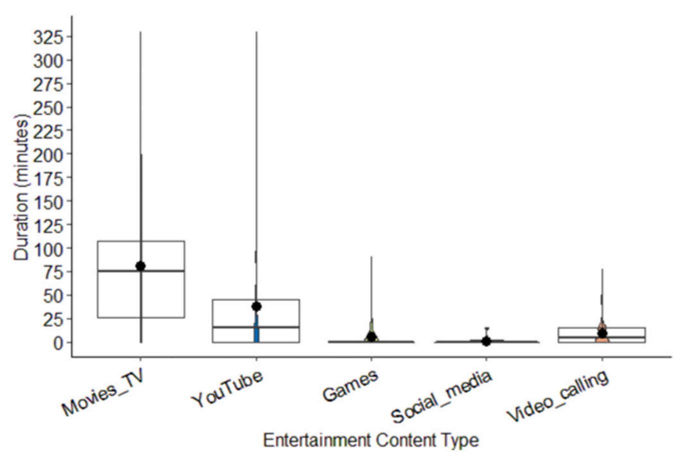

Fig. 1. Entertainment content box and violin plots for the raw engagement durations (min) averaged over weekdays and weekends.
Note. Dots denote the means.

Table 2
Media devices in children's households and weekly usage rates.

	Laptop	Desktop computer	Tablet/iPad/ surface	Smart phone	TV	Non-hand held gaming console	Hand held gaming console	e-Reader
At least one in household %	90.48	44.23	91.43	99.06	92.45	51.43	24.04	18.81
Child owns %	0.00	0.94	22.86	4.72	3.77	0.94	0.94	0.00
Use at least 2–3 days per week %	12.15	10.38	76.15	70.09	90.65	19.81	12.26	1.02
Use at least 4–5 days per week %	0.93	0.00	34.86	19.63	73.83	4.72	1.89	1.02

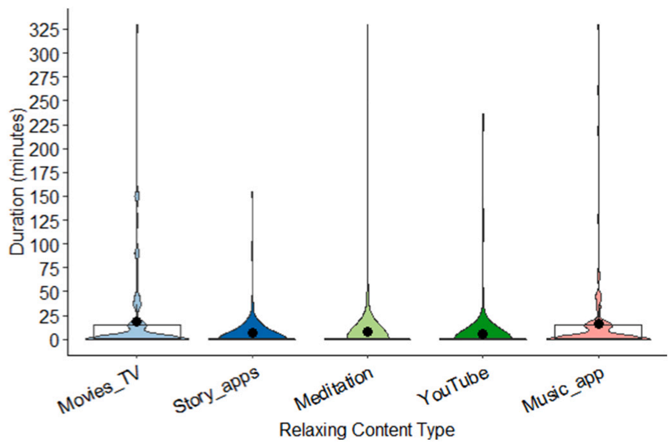

Fig. 2. Relaxing content box and violin plots for the raw engagement durations (min) averaged over weekdays and weekends.
Note. Dots denote the means.

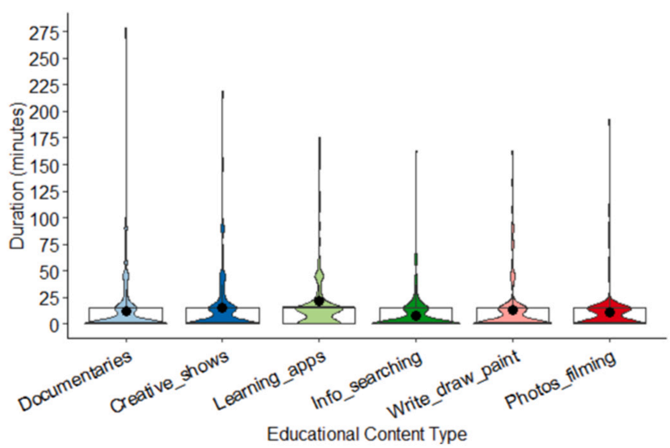

Fig. 3. Educational content box and violin plots for the raw engagement durations (min) averaged over weekdays and weekends.
Note. Dots denote the means.

Table 3
Average daily engagement durations by content type and whether it occurs in evenings and predominantly with someone or alone.

	n engaged in content type	*M* duration per day (min)	*SD*
Entertainment content average (outliers replaced by means)	103 (100 %)	117.74	72.96
Watch in Evenings (> 5 nights)			
Yes	46	141.91	76.95
No	55	97.48	64.61
With someone	81	113.71	69.19
Alone	20	133.93	89.37
Relaxing/calming content average (outliers replaced by means)	61 (59 %)	63.01	59.49
Watch in evenings (> 5 nights)			
Yes	32	63.19	59.91
No	28	58.39	56.19
With Someone	48	59.18	58.63
Alone	10	71.03	58.79
Educational content average (outliers replaced by means)	88 (86 %)	62.92	50.93
Watch in evenings (>5 nights)	23	82.24	55.22
Yes			
No	65	55.54	47.84
With someone	62	60.09	45.59
Alone	23	74.51	63.89

in Supplementary Materials, but should be interpreted with caution as they are underpowered.

3.2. Sleep and screen time duration, time of day

3.2.1. Sleep duration

Average sleep duration (see Table 4) and time spent watching entertainment content were not normally distributed, so any *z*-scores >2/−2 (sleep duration: $n = 5$; entertainment screen time $n = 4$) were replaced with the variable mean. This improved the distribution for both. Roughly half of the children engaged with screens during the day only and the remaining also engaged with screens after dinner and/or before bed (see Table 3). Child age and caregivers' number of years in education were entered first into the model ($R = 0.07$, $R^2 = 0.00$, $R^2_{adj} = -0.02$, $F(2,94) = 0.22$, $p = .804$). Both of these were non-significant predictors of sleep duration (see Table 5). A second model was added which included average duration spent watching entertainment content, and whether or not this occurs in the evening, as well as an interaction between the two ($R = 0.30$, $R^2 = 0.09$, $R^2_{adj} = 0.04$, $F(5,91) = 1.80$, $p = .121$). This led to a significant difference between the models ($\Delta R^2 = 0.09$, $F(3,91) = 2.84$, $p = .042$). This was explained by the time spent watching entertainment content, which was a significant negative predictor. The more time spent watching entertainment content the shorter the sleep duration (see Table 5). The interaction between entertainment content time and whether it was watched in the evening was a non-significant predictor of sleep duration (see Fig. 4).

3.2.2. Sleep quality

Child age and caregivers' number of years in education were both non-significant predictors of sleep quality in model 1 ($R = 0.06$, $R^2 = 0.00$, $R^2_{adj} = -0.02$, $F(2,94) = 0.19$, $p = .830$) and model 2 ($R = 0.32$, $R^2 = 0.10$, $R^2_{adj} = 0.05$, $F(5,91) = 0.22$, $p = .082$). The second model with entertainment content duration (minutes), and whether or not viewing occurred in the evening, along with the interaction between the two, led to a significant difference between the models ($\Delta R^2 = 0.10$, $F(3,91) = 3.25$, $p = .025$). The more time spent watching entertainment content significantly predicted poorer quality sleep (see Table 6). The interaction between entertainment content duration and whether it is watched in the evening was a non-significant predictor of sleep quality (see Fig. 5).

3.3. Developmental outcomes and screen time duration, sleep duration, form of screen media usage (alone vs. with someone)

3.3.1. Communication (Ages and Stages Questionnaire-3)

Communication scores were negatively skewed, so they were reversed and square-root transformed, which improved the distribution. For ease of interpretation, the non-reversed scores are presented (see Fig. 6). Caregivers' years in education was entered into the first model ($R = 0.16$, $R^2 = 0.03$, $R^2_{adj} = -0.02$, $F(1,87) = 2.35$, $p = .129$). Child age was not included as each score is based on questionnaires for the different age groups (see Table 1 for age ranges). Caregiver education was a non-significant predictor of communication scores (see Table 7).

Table 4
Descriptive statistics for caregiver years in education, sleep and developmental variables.

	n	*M*	*SD*
Average sleep duration (h)	101	10.74	0.64
Average sleep duration (h)(outliers replaced)	101	10.80	0.53
Sleep quality (Child Sleep Wake Scale)	95	4.18	0.59
Caregiver education (years)	97	16.63	3.40
Communication (Ages & Stages Questionnaire)	93	52.15	10.01
Problem solving (Ages & Stages Questionnaire)	91	54.62	8.24
Attention problems T-scores (Child Behavior Checklist 1.5–5)	97	53.09	5.19

Table 5
Model 2 coefficients for entertainment screen content and average sleep duration.

Predictor	Estimate	*SE*	95 % confidence interval		*t*	*p*	Stand. estimate	95 % confidence interval	
			Lower	Upper				Lower	Upper
Intercept	11.36	0.44	10.48	12.24	25.56	< 0.001			
Child age	−0.06	0.07	−0.19	0.07	−0.91	0.368	−0.09	−0.30	0.11
Caregiver years education	−5.28e−4	0.02	−0.03	0.03	−0.03	0.973	−0.00	−0.20	0.20
Entertainment content duration (min)	**−0.00**	**0.00**	**−0.00**	**−3.57e−4**	**−2.34**	**0.022**	**−0.34**	**−0.62**	**−0.05**
Watch in the evening (no-yes)	−0.11	0.21	−0.52	0.31	−0.50	0.617	−0.08	−0.50	0.34
Entertainment content duration ✻ watch in the evening	5.35e-4	0.00	−0.00	0.00	0.35	0.725	0.08	−0.35	0.50

Rows in bold indicate that p <.05.

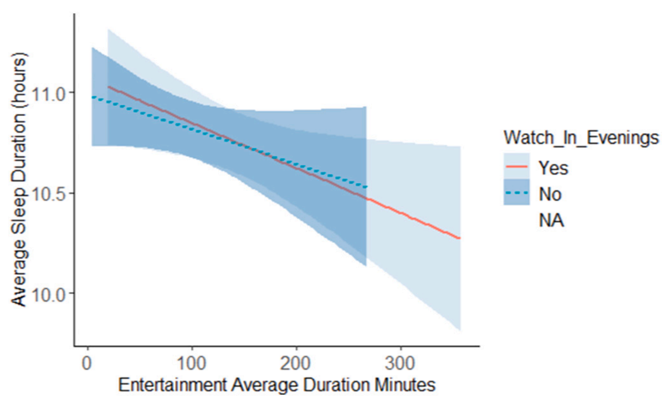

Fig. 4. Average sleep duration (hours) and average time spent watching entertainment content and whether this occurs in the evening or not.

The variables entered into the next model were average sleep duration, average time spent watching entertainment content, whether it was predominantly watched with someone or alone, and the interaction between the last two variables. This was associated with a significant model fit ($R = 0.37$, $R^2 = 0.14$, $R^2_{adj} = 0.09$, $F(5,83) = 2.66$, $p = .028$), and a significant change in the model ($\Delta R^2 = 0.11$, $F(4,83) = 2.70$, $p = .036$), but only time spent watching entertainment content was a significant predictor of communication scores (see Table 7). More time spent watching entertainment content was associated with poorer communication scores (see Fig. 6).

3.3.2. Problem solving (ASQ-3)

Problem solving scores were negatively skewed, so they were reversed and square-root transformed which improved the distribution. The non-reversed scores are presented to facilitate interpretation (see Fig. 7). Caregivers' years in education was entered into the first model ($R = 0.25$, $R^2 = 0.06$, $R^2_{adj} = 0.05$, $F(1,86) = 5.55$, $p = .021$), and was a significant positive predictor of problem solving — more years was associated with higher problem solving scores (see Table 8). The variables entered into the next model were average sleep duration, average time spent watching entertainment content, whether it was predominantly watched with someone or alone, and the interaction between the last two variables. This was associated with a significant model fit ($R = 0.43$, $R^2 = 0.19$, $R^2_{adj} = 0.14$, $F(5,82) = 3.82$, $p = .004$), and a significant change in the model ($\Delta R^2 = 0.13$, $F(4,83) = 3.24$, $p = .016$). Sleep duration was a non-significant predictor, but time spent watching

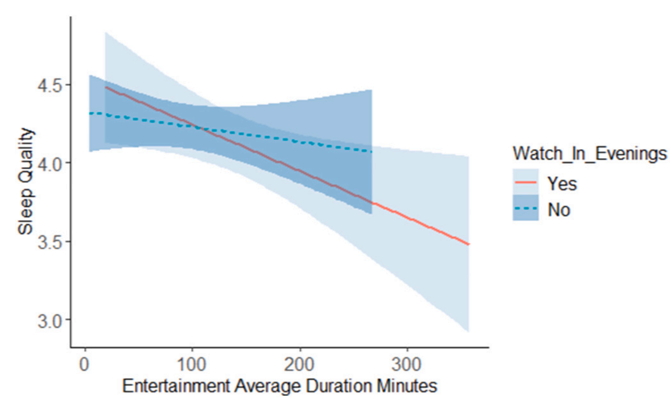

Fig. 5. Average sleep quality and average time spent watching entertainment content and whether this occurs in the evening or not.

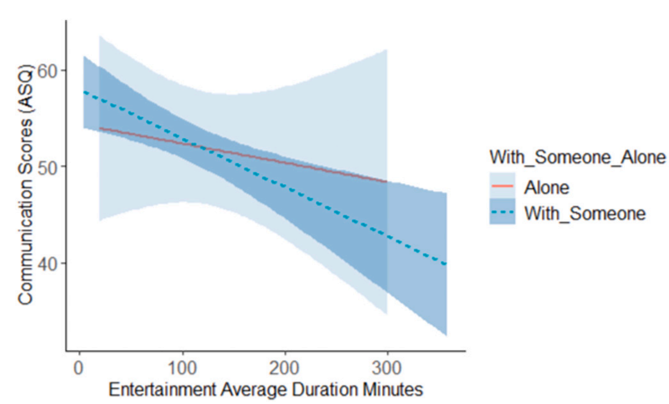

Fig. 6. Communication scores (Ages and Stages Questionnaire) and average time spent watching entertainment content and whether this occurs with someone or alone.

Table 6
Model coefficients for entertainment screen content and sleep quality (Child Sleep Wake Scale).

Predictor	Estimate	*SE*	95 % confidence interval		*t*	*p*	Stand. estimate	95 % confidence interval	
			Lower	Upper				Lower	Upper
Intercept	4.93	0.49	3.96	5.90	10.12	< 0.001			
Child age	−0.03	0.07	−0.17	0.11	−0.38	0.705	−0.04	−0.24	0.16
Caregiver years education	−0.02	0.02	−0.05	0.02	−0.93	0.356	−0.09	−0.29	0.11
Entertainment content duration (min)	**−0.00**	**0.00**	**−0.01**	**−8.69e−4**	**−2.76**	**0.007**	**−0.40**	**−0.68**	**−0.11**
Watch in the evening (no-yes)	−0.20	0.23	−0.66	0.25	−0.89	0.377	0.03	−0.39	0.45
Entertainment content duration ✻ watch in the evening	0.00	0.00	−0.00	0.01	1.14	0.257	0.24	−0.18	0.66

Rows in bold indicate that p <.05.

Table 7
Model coefficients for entertainment screen content and communication scores reverse scored (Ages and Stages Questionnaire).

Predictor	Estimate	SE	95 % confidence interval		t	p	Stand. estimate	95 % confidence interval	
			Lower	Upper				Lower	Upper
Intercept	5.86	4.49	−3.06	14.70	1.31	.195			
Caregiver years education	−0.07	0.06	−0.18	0.05	−1.21	.231	−0.12	−0.33	0.08
Sleep duration	−0.35	0.39	−1.14	0.43	−0.90	.372	−0.10	−0.31	0.12
Entertainment content duration (min)	**−0.01**	**0.00**	**0.00**	**0.02**	**2.71**	**.008**	**0.33**	**0.09**	**0.58**
With someone vs. alone (alone-with someone)	0.80	0.99	−1.16	2.77	0.81	.419	0.08	−0.44	0.61
Entertainment content duration ✻ with someone/alone	−0.01	0.01	−0.02	0.01	−0.83	.411	−0.20	−0.67	0.28

Rows in bold indicate that p <.05.

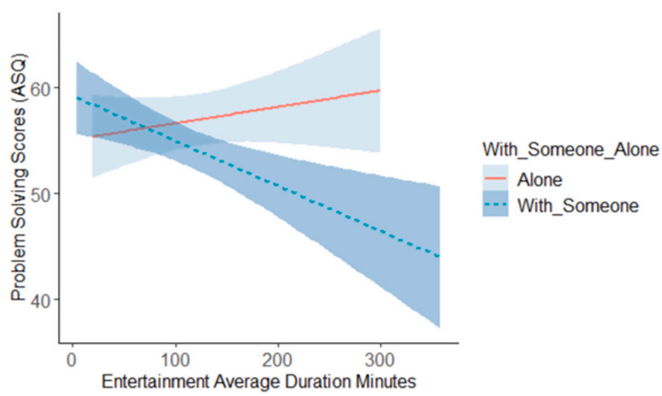

Fig. 7. Problem solving scores (Ages and Stages Questionnaire) and average time spent watching entertainment content and whether this occurs with someone or alone.

entertainment content was a significant predictor of problem solving scores (see Table 8). Greater time spent watching entertainment content was associated with poorer problem solving scores (see Fig. 7). There was also a significant interaction between time spent watching entertainment content and whether it was watched with someone or alone. The more it was done with someone, the poorer the problem solving scores, whereas time spent watching entertainment content alone was associated with better problem solving scores.

3.3.3. Attention problems (CBCL)

Due to the Attention Problem T-Scores being positively skewed, they were log-transformed. Child age was included here because CBCL covers ages from 1.5 to 5 years. Child age was entered into the first model (R = 0.15, R^2 = 0.02, R^2_{adj} = 0.01, F(1,95) = 2.14, p = .147), and was a non-significant predictor of attention problems (see Table 9). In the next model, average sleep duration, average time spent watching entertainment content, whether it was predominantly watched with someone or alone, and the interaction between the last two variables were entered (R = 0.31, R^2 = 0.09, R^2_{adj} = 0.04, F(5,91) = 1.90, p = .102). The change in models was non-significant (ΔR^2 = 0.07, F(4,91) = 1.82, p = .131). Only time spent watching entertainment content was a significant predictor of attention problems (see Table 9). Greater time spent watching entertainment content was associated with greater attention problems (see Fig. 8 for original scores).

3.3.4. Adjustment for multiple tests

'Entertainment content duration' was a significant predictor in each of the five multiple regression analyses, but as it was used repeatedly, an adjustment should arguably be made for multiple testing. Each DV was also used three times across the three content types (see Supplementary Materials for the relaxing and educational content analyses). Using the Benjamini-Hochberg method for adjusting for a false discovery rate (e.g., Yekutieli & Benjamini, 1999), the following critical p-values were derived for each of the analyses for the following DVs reported above (problem solving: 0.006; sleep quality: 0.013; communication: 0.019; attention problems: 0.025; sleep duration: 0.031). All of the p-values for entertainment content duration are lower than the adjusted p-values.

4. Discussion

The children in this sample primarily engaged in entertainment

Table 8
Model coefficients for entertainment screen content and problem solving scores reverse scored (Ages and Stages Questionnaire).

Predictor	Estimate	SE	95 % confidence interval		t	p	Stand. estimate	95 % confidence interval	
			Lower	Upper				Lower	Upper
Intercept	3.61	4.08	−4.50	11.72	0.89	.378			
Caregiver years education	**−0.12**	**0.05**	**−0.22**	**−0.01**	**−2.21**	**.030**	**−0.22**	**−0.42**	**−0.02**
Sleep duration	−0.10	0.36	−0.81	0.62	−0.27	.788	−0.03	−0.23	0.18
Entertainment content duration (min)	**0.01**	**0.00**	**0.00**	**0.02**	**2.95**	**.004**	**0.35**	**0.11**	**0.58**
Alone - with someone	1.55	0.90	−0.25	3.34	1.72	.090	−0.22	−0.74	0.29
Entertainment content duration ✻ with someone/alone	**−0.02**	**0.01**	**−0.03**	**−0.00**	**−2.78**	**.007**	**−0.65**	**−1.12**	**−0.19**

Table 9
Model coefficients for entertainment screen content and attention problems (Child Behavior Checklist 1.5–5).

Predictor	Estimate	SE	95 % confidence interval		t	p	Stand. estimate	95 % confidence interval	
			Lower	Upper				Lower	Upper
Intercept	1.61	0.09	1.44	1.79	18.20	<.001			
Child Age	0.01	0.00	0.00	0.02	1.53	.130	0.15	−0.05	0.35
Sleep Duration	0.01	0.01	−0.01	0.02	0.72	.476	0.07	−0.13	0.28
Entertainment Content Duration (min)	**1.67e-4**	**6.38e-5**	**4.05e-5**	**2.94e-4**	**2.62**	**.010**	**0.31**	**0.07**	**0.54**
Alone – with someone	0.03	0.02	−0.01	0.06	1.52	.131	0.15	−0.36	0.66
Entertainment content duration ✻ interactive/alone	−0.91e−4	1.27e-4	-4.44e-4	6.22e-5	−1.50	.137	−0.35	−0.82	0.11

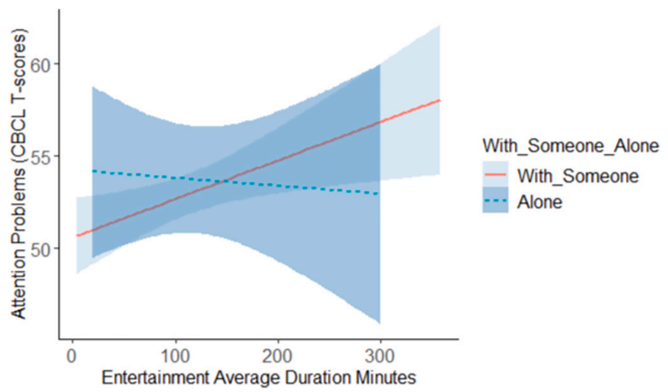

Fig. 8. Attention problems (CBCL 1.5–5) and average time spent watching entertainment content and whether this occurs with someone or alone.

content, rather than relaxing or educational content. The total daily average duration spent on entertainment content was nearly 2 h which is beyond recommendations (e.g., World Health, 2019). The longest durations were spent on entertainment TV and movies. Just over half of the children engaged in relaxing/calming content and 86 % engaged in educational content. Of the ones who engaged with these content types, the total daily average duration was about an hour. However, looking at the individual categories of relaxing and educational content, mean durations were relatively short (~15 min). This could be a reflection of the age group, but this provides an interesting picture of content types engaged in by children of this age. It is important to note that this data is also based on how caregivers perceive the content. The durations could also be a reflection of the nature of the content types. Entertainment content is usually longer and typically involves passive engagement, whereas calming or learning applications usually involve shorter time spans and greater cognitive engagement. Entertainment content might also be easier to access and require less assistance by caregivers.

4.1. Screen time and sleep

As all the children engaged in entertainment content for more than negligible times, this was the focus of the analyses. When it came to sleep, longer durations spent engaged in entertainment content was associated with shorter sleep and poorer sleep quality. This aligns with the findings of previous studies (Janssen et al., 2020). The Australian government recommends children in this age range sleep between 10 and 13 h (health.gov.au, 2021). Those using screens beyond 1 h had sleep durations within that range, but there was a downward trend in sleep durations as entertainment screen time increased (see Fig. 4). This is the first known report of findings with sleep quality measured by the CSWS. Children watching beyond 1 h had scores below 4, which is indicative of sleep behavior and sleep onset difficulties. Child age and whether screen time occurred at night or not did not contribute significantly to the models, and the direction of the association was the same for those children who engaged in screens at night and those who did not.

4.2. Screen time and language

Greater entertainment screen time was also associated with lower communication scores suggesting that language development is weaker among those engaging in longer screen times. Scores in the current study are largely within normal range, but the scores that are indicative of poorer development (<40) were associated with durations beyond 3 h (Fig. 6). Duch et al. (2013) also found that >2 h of screen time was associated with poorer ASQ communication scores (see also Byeon & Hong, 2015). Hutton et al. (2020) found that the association between screen time and poorer language development was associated with poorer integrity in white matter in brain areas that support language and executive function skills. Therefore, this is worthy of further attention.

4.3. Screen time and cognition

Greater screen time was also associated with lower problem solving scores, and whether children engaged in the content alone or with someone significantly interacted with screen time. Surprisingly, engaging in screen time alone was associated with better problem solving scores, but engaging with someone was associated with poorer problem solving scores. Greater years in caregivers' education was also associated with higher problem solving scores. Scores that are indicative of poorer development (<40) were associated with screen use durations beyond 4 h (Fig. 7). It was unexpected that there would be lower problem solving scores with greater screen time watching with someone. This could be explained by children being less engaged with screen content when with someone, and the screens being more like background content. More engaging content is associated with positive outcomes (Linebarger & Walker, 2005), but background TV is associated with poorer vocabulary sizes (Masur et al., 2016). The findings could also be explained by the quality of interaction with others. Caregivers speak more and with a richer vocabulary to their toddlers during storybook reading than during TV co-viewing (Hanson et al., 2021). Shah et al. (2021) found that greater conversation between caregivers and their children during screen time was associated with greater levels of curiosity, and this was particularly the case for children from lower socioeconomic backgrounds. Those watching alone in the current study could perhaps be more independent and engaged in more curiosity-driven behavior. We did not collect data on the degree to which children interacted with others, and given the significant interaction this needs further investigation.

Greater entertainment screen times also predicted higher scores on the CBCL attention problems subscale. This was also found by Tamana et al. (2019) with the same subscale. In the current study, the majority of the scores are within normal range for the CBCL attention problems subscale (scores below 65), yet the trend was for higher scores with greater entertainment screen time. This is in contrast with Portugal et al.'s (2021) findings that toddlers' higher screen times are associated with faster visual search times. The current findings could be due to this analysis involving entertainment content. Complex, fast moving, salient content is associated with poorer attention in preschoolers (Essex et al., 2022).

4.4. Content types

As fewer children engaged with relaxing/calming and educational content, the analyses for these content types are underpowered, but the findings indicate that the association between time spent on these content types and sleep, and language and cognitive development are non-significant (see Supplementary Materials). We compared the standardised coefficients across the content type durations. For sleep duration, the standardised estimate for entertainment content duration as a predictor was −0.40, for relaxing/calming it was −0.03, and for educational it was −0.45 (see Table 5 and Tables A1 and B1 in Supplementary Materials). Therefore, despite educational content duration being a non-significant predictor of sleep duration, the strength of the relationship was similar to that seen with entertainment content duration. For sleep quality, the standardised estimate for entertainment content duration as a predictor was −0.34, for relaxing/calming it was −0.31, and for educational it was −0.28. Therefore, despite relaxing/calming and educational content durations being non-significant predictors, the strength of relationship with sleep quality was similar to the relationship seen with entertainment content.

However, for the developmental variables, entertainment content duration was a stronger predictor than relaxing/calming and educational content. For communication (reverse transformed), the standardised estimate for entertainment content duration was 0.33, for relaxing/calming it was 0.01, and for educational it was 0.16. Similarly, for problem solving (reverse transformed), the standardised estimate for entertainment content duration as a predictor was 0.35, for relaxing/calming it was 0.14, and for educational it was 0.16. For attention problems, the standardised estimate for entertainment content duration as a predictor was 0.31, for relaxing/calming it was 0.06, and for educational it was 0.21. The findings suggest that the role of differing content types is worth further investigation. Fewer children in this age range engaged with these content types, but it is possible they have similar associations with sleep duration and sleep quality as time spent engaged with entertainment content, but weaker associations with cognition.

4.5. Theoretical implications

Sufficient and good quality sleep are both important for early child functioning and development (Hill et al., 2007). Current results provide further evidence of poorer sleep with greater screen time. Screen time at night was also expected to play a role in sleep (Nathanson & Beyens, 2018). This could be due to the exposure to light and in particular blue light emitted by screens, which can suppress melatonin levels and disrupt circadian rhythms (Akacem et al., 2018; Aubé et al., 2013; Brainard et al., 2001; Oh et al., 2015; von Gall, 2022). Time spent engaged with screens could compete with the time falling asleep; and certain content can be physiologically inducing children to remain awake (Hale et al., 2018). However, more than half of the caregivers in the current study reported that their child did not engage with screens at night (see Table 3). Those engaging with screens during the day only, had the same pattern of findings as those watching at night - greater screen time predicted poorer sleep. This could suggest that screen time during the day is sufficient to affect sleep at night. Screen time likely increases sedentary behavior during the day replacing time spent being active, which is associated with better sleep quality (Kline et al., 2021). Chandra et al. (2016) found that Australian infants and toddlers with >2 h of screen exposure went on fewer outings, had no outdoor play equipment, were more likely to have only one caregiver and fewer siblings. These factors indicate that greater screen time could also be a result of less opportunity for play and activity.

It is recommended that children in this age range sleep between 10 and 13 h at night (health.gov.au, 2021), and looking at Fig. 4 for sleep duration, most of the children sleep within this range, but it appears that a small number engaging with entertainment content at night are sleeping <10 h. For sleep quality, scores below 4 (a score indicative of sleep behavior and sleep onset difficulties) seem to be associated with those engaging with screens in the evening (see Fig. 5). Therefore, despite the interaction with night time use being non-significant, there are some minor indications that night time screen engagement could be associated with sleep issues. However, for this sample, there is very little time for children to engage with night time use. Caregivers were asked whether children engaged with screens after dinner as well as before bed. For entertainment content, 46 % were reported to engage with screens after dinner, and 25 % were reported to engage with screens before bedtime. However, the average time that children were reported to start bedtime routines was 6:48 pm and the average time they were reported to fall asleep was 7:48 pm. With this age group, there is likely little distinction between after dinner and before bedtime screen use. Nonetheless, future studies should include questions surrounding blue light and brightness dimming settings and the type of device children use at night. There might be differing effects of the device used due to the distance to the screens (Chindamo et al., 2019; Figueiro et al., 2010; Oh et al., 2015; Wood et al., 2013; Yoshimura et al., 2017).

Despite the importance of sleep for cognitive and language development (Mason et al., 2021), sleep duration was not a significant predictor for communication, problem solving and attention problems. Nathanson and Beyens (2018) found that greater screen time in preschoolers predicted poorer performance in cognitive tasks, but this was moderated by shorter sleep durations. Here, screen time played a dominating role despite it also being associated with shorter sleep and poorer sleep quality. Time spent on screens could replace children's time conversing with others, which could affect language development (Hanson et al., 2021). Time spent on screens could also lead to a reliance on bottom-up processing (Essex et al., 2022), and replace curiosity-driven behavior (Shah et al., 2021). It is not entirely certain that it is screen time per se that is driving the findings or a lack of other activities.

4.6. Limitations and future directions

The study was based on caregiver reports, and the questions surrounding durations were based on an average daily amount over the previous month. This retrospective form of data collection is limited by caregivers' memory and accuracy is limited with self-report measures compared to regular log keeping of screen time (Parry et al., 2021). Contrary to the hypotheses, engaging with entertainment content at night was non-significantly related to sleep duration and quality. Half of parents reported that their child engaged with screens at night, so looking at it categorically was suitable. However, daily diaries might provide better accuracy for this variable and allow us to investigate this as a continuous variable based on durations. Finally, during part of the data collection phase (mid-September–October), some parts of Australia were in lockdown, so screen times could have been amplified, and they might not be representational of typical durations.

Greater numbers are needed to provide sufficient power for the analyses for the relaxing and educational content given that some children did not engage with these content types. It is also difficult to definitively fit content types into the three categories. While the content types might be aimed at being relaxing, entertaining, or educational, they might not necessarily have that specific effect; and different media types could overlap (e.g., educational content may be experienced as entertaining). Future studies with the questionnaires delivered in person, will allow for greater clarification as to what constitutes as entertainment, relaxing, and educational content, and ensure that caregivers do not provide overlapping durations across the content types.

Contrary to the hypotheses, there were higher problem solving scores when participants tended to engage in screen content with someone, but not when children tended to engage in screen time on their own. Greater clarity is required for this question for this age group. The majority of caregivers answered that their child engaged in content with someone. This is an age where children should not be left alone. It is not entirely clear if watching with someone meant that they engaged in the content together or were merely near another person.

Future studies should also consider the role of caregivers as there is evidence that authoritarian and strict or more permissive parenting styles are associated with greater screen time in children, whereas more authoritative styles and greater monitoring of children's daily activities are associated with less screen time (Detnakarintra et al., 2020; Langer et al., 2014; Lloyd et al., 2014). There are potential longer-term associations as Detnakarintra et al. (2020) found that parents with more nurturing and communicative styles of interacting with their children during infancy was associated with shorter screen times during the preschool years.

Considerations should also be made for factors that might predispose children to screen time behaviours. Greater screen time in parents is associated with greater screen time in their children, based on both parents' current screen time use and when parents were children (Steffen et al., 2013). Bonassi et al. (2020) found that adults who had a greater genetic risk for vulnerabilities to life events and who reported low paternal care or high maternal overprotection during childhood had lower sociability on social media (postings and followers). Greater screen time is also associated with lower well-being in children raising questions as to whether screen time precedes lower well-being or vice versa (Twenge et al., 2019). Longitudinal studies suggest that it is the former, but others indicate bi-directional relationships (Gunnell et al., 2016). Therefore, considering caregiver behaviours, early parental relationships, and children's well-being could help in better understanding potential influences on screen time.

The data collected from this study was aimed at informing future research studies that will focus on more specific aspects of development and more direct measures of cognition and attention. Questionnaire-based measures, albeit validated, are limited in what they can measure. The ASQ-3 is a brief screening tool, and behavior rating scales such as the CBCL can be dependent on the rater (Achenbach & Rescorla, 2000). Nonetheless, the findings here did support the findings of others using the communication domain of the ASQ-3 (Byeon & Hong, 2015; Duch et al., 2013); and the attention problems subscale of the CBCL (Tamana et al., 2019). When it comes to sleep durations, parents tend to overestimate children's sleep durations and underestimate their night awakenings (Sadeh, 1996; So et al., 2007). Our future studies will involve measuring sleep duration and quality objectively with actigraphy in conjunction with daily sleep diaries (Sadeh, 2011).

Finally, caregiver years in education was included in the analyses, but socioeconomic status (SES) is also needed due to reports of associations with screen time (Carson & Kuzik, 2017; Napier, 2014; Shah et al., 2021). The sample was also homogeneous in terms of ethnicity, but as screen time can differ in children across ethnicities (Reus & Mosley, 2018), future studies should ensure a greater representation of a variety of ethnicities.

5. Conclusions and practical implications

Current findings indicate that screen time, irrespective of timing of use, is associated with poorer sleep and poorer language and cognitive development. There is a finite number of waking hours in a child's day and longer screen engagement durations could be reducing time on activities that are more conducive to optimal development. It is uncertain as to whether screen time has direct effects on sleep and developmental outcomes or if screen time is replacing the time children could spend being active, communicating with others and actively exploring their world from their own initiative. Interventions for more optimal screen media use in preschoolers have been found to be successful (Garrison & Christakis, 2012). Public health interventions further promoting the benefits of lower screen time usage may be needed. This might include construction of clearer guidelines for the use of screen devices in childcare settings and in the home. In addition, clinicians working with children should assess screen time use as part of standard practice. Screen time in children with developmental disorders is also worthy of attention as they tend to experience sleep difficulties (Halstead et al., 2021). There is some evidence of greater screen time and shorter sleep durations among school children with developmental disorders (Aishworiya et al., 2018), and relative to typically developing (TD) children, greater proportions of children with ASD have been found to engage in poorer health-related behaviours including screen time (Garcia & Hahs-Vaughn, 2021). Sleep duration and frequency of interactions with caregivers was found by Chen et al. (2020) to mediate long-term associations between early screen time and autistic-like behaviours in the preschool years, Caregivers' lack of limit setting is also associated with greater screen time in children with ASD (Healy et al., 2020). Therefore, the influence of caregivers and sleep are important in longer-term outcomes of screen time among TD children and children with developmental disorders.

Declaration of competing interest

We declare that we have no conflicts of interest associated with this research.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.actpsy.2022.103762.

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