Cognitive Development 66 (2023) 101319

Contents lists available at ScienceDirect

Cognitive Development

journal homepage: www.elsevier.com/locate/cogdev

Young children and screen-based media: The impact on cognitive and socioemotional development and the importance of parental mediation

Edyta Swider-Cios [a], Anouk Vermeij [a,b], Margriet M. Sitskoorn [a,*]

[a] Department of Cognitive Neuropsychology, Tilburg University, Postbus 90153, 5000 LE Tilburg, Tilburg, the Netherlands
[b] Netherlands Organization for Health Research and Development (ZonMw), ZonMw Postbox 93 245, 2509 AE, The Hague, the Netherlands

ARTICLE INFO

Keywords:
Cognitive development
Screen-based media
Parental role
Early childhood

ABSTRACT

Young children are deeply immersed in digital technologies and the way children interact with screen-based media during early childhood is constantly changing. Literature shows that the use of screen-based media in early childhood can have both positive and negative impacts on children's cognitive and socioemotional development. In this literature review, we describe the risks and benefits of screen-based media use on cognitive and socioemotional development by reviewing research findings published since 2010. Specifically, we focus on the influence of screen-based media on children between 0 and 5 years of age, as it is a period of accelerated brain development and emergence and growth of cognitive abilities within several cognitive domains. We describe findings around content-based, content-independent, form-based, and social-based theories of the impact of screen-based media on development, highlighting the role parents play in their children's relationship with screen-based media. Finally, we provide recommendations for future research and practical guidelines for parents, medical practitioners, policymakers, and the media industry.

1. Introduction

Over the past years, young children (0–5 years of age) have been engaging more and more in screen-based activities using various devices, e.g., television, smartphones, or tablets, which are now part of their day-to-day lives (Chen & Adler, 2019; Kabali et al., 2015; Madigan et al., 2020; Common Sense Media, 2013). This increase has been even more pronounced due to COVID-19 pandemic lockdowns (Bergmann et al., 2022). On the one hand, screen-based activities can stimulate imagination and creativity, but on the other hand, they can lead to difficulties with staying focused or regulating emotions (Livingstone & Pothong, 2022; Tamana et al., 2019). Research suggests that newer media, including tablets and smartphones, offer both benefits and risks to the health of children, especially under the age of 5 years (Alade et al., 2016; Cheung et al., 2017; Chindamo et al., 2019; Gordon-Hacker & Gueron-Sela, 2020; Kirkorian et al., 2016; Lauricella et al., 2016; Moser et al., 2015; Myers et al., 2017; Rocha & Nunes, 2020). The World Health Organization (WHO) and the American Academy of Pediatrics (AAP) created official screen-time recommendations for young children. WHO recommendations state that children under the age of 5 should not spend more than one hour daily on screen-based activities, while children younger than 1 should not be exposed to this type of activity at all (WHO, 2019). AAP calls for no screen time

* Corresponding author.
E-mail address: m.m.sitskoorn@tilburguniversity.edu (M.M. Sitskoorn).

https://doi.org/10.1016/j.cogdev.2023.101319
Received 16 May 2022; Received in revised form 17 February 2023; Accepted 27 February 2023
Available online 13 March 2023

for children until 18–24 months, with an exception for video chatting, and for children from 2 to 5 years of age, screen time should be limited to one hour per day (AAP, 2016).

Despite official recommendations, many children have their first experience with screen time, already in their infancy, and once they reach pre-school age, they show well-established patterns and habits of screen time (Chaudron et al., 2018). As early childhood is filled with critical periods of brain development, which lead to the emergence and growth of cognitive abilities within several domains, such as focused attention, memory, executive functions, and language (Carson et al., 2015), exposure to screen-based media during the early years can influence child's optimal functioning and growth. It can also affect children's neuroplasticity, with positive experiences leading to brain changes that promote learning and enhance cognitive abilities, and poor experiences resulting in brain changes that hamper cognitive development (Kolb & Gibb, 2011). Furthermore, exposure to screen-based media can affect socioemotional development (Cliff et al., 2018; Desmarais et al., 2021; Lin et al., 2020; Wan et al., 2021). The development of socioemotional abilities in childhood goes along with the development of cognitive skills and together, emotion and cognition contribute to attentional processes and learning (Cacioppo & Berntson, 2016). Additionally, socioemotional development plays a crucial role in influencing children's school performance and lifelong learning (Zins et al., 2007). Research suggests that neural mechanisms involved in emotion and cognition are highly linked; for example, the regulation of emotions is strongly supported by core executive functions (Bell & Wolfe, 2004). Thus, brain structures involved in cognitive processing may influence socioemotional processing and vice versa (Barrett et al., 2006). Therefore, to understand the impact of screen-based media on children's development, it is important to integrate cognitive and socioemotional perspectives.

In this literature review, we describe findings on the influence of screen-based media on cognition and socioemotional development of children from 0 to 5 years. Furthermore, as parents may play an important role in shaping the attitude of their children toward digital technology and in helping to reduce the negative influences of screens, we also describe how parental behavior can influence a child's interaction with screen-based media. As the relationship between screen-based media and cognitive and socioemotional development can be affected by multiple factors, we describe literature findings around content-based, content-independent, and form-based theories of the impact of screen-based media on development (Anderson et al., 2001; Scarf & Hinten, 2018). We also add social-based theories, where we highlight the importance of parental role and mediation in children's relationship with screen-based media. By evaluating research findings published since 2010, we address several questions: 1) How do different aspects and types of screen-based media use affect the cognitive and socioemotional development of young children? 2) What is the parental role and how can parents help their young children to develop a healthy relationship with screen-based media? 3) What should parents, healthcare providers, and the media industry do to help children get the best out of what screen-based media have to offer?

2. Methods

The literature search for this review was done via PubMed, Google Scholar, PsycINFO, and Web of Science. The main terms included in the search were: 'digital media', 'screen time', 'screen exposure', 'screen-based media', 'cognitive development', 'socio-emotional development', 'young children', 'early childhood', 'parental role', 'parental mediation'. More specifically, the terms 'early childhood', 'young children', 'cognitive development', 'socioemotional development', 'parental mediation', 'parental role' were paired and searched individually with the terms 'digital media', 'screen time', 'screen exposure', and 'screen-based media'. Additionally, manual screening of reference sections of selected publications was done to extract additional literature meeting criteria. Overall, the articles were selected if the main terms were included within an article title, abstract, or keywords. The collected literature was screened again and duplicates were removed. When it was not possible to determine whether a publication should be included based on the abstract screening, the full article was examined. Several inclusion criteria were used, specifically: articles published between January 2010 and January 2022, peer-reviewed articles published only in English, and articles describing findings for children between 0 and 5 years. Furthermore, this review includes publications that describe findings from participants not older than 5 years or, if also older children participated in a study, describe the findings on the 0–5 years age group separately. For longitudinal studies, publications were included if participants were between 0 and 5 years during the first collection of data. Finally, publications describing the use of eBooks or publications that included children with mental disorders, autism, ADHD, or severe behavioral problems, were not included. The literature search was as thorough and extensive as possible. Since this is a narrative review, we highlight literature findings that may not necessarily represent the whole filed. Thus, some publications might have not been included in this review. Nevertheless, we think that our review brings a new perspective on looking at the impact of screen-based media on young children and highlights the limitations of current research.

For the aim of clarity, when describing influences on cognition, the focus was put on executive functions, attention, learning, and language domains. Attention can be viewed as an executive function. Nevertheless, in the reviewed literature, attention is often addressed separately, next to executive functions. Thus, when describing the effects of screen-based media on cognitive development, we addressed these two cognitive abilities separately. For socioemotional development, selected publications focus on changes in expressing and regulating emotions, (internal and external) behavior, the ability to understand the feelings of others, and forming close relationships.

2.1. Early development and screen-based media within content-based theories

Theories of the impact of screen-based media on development that belong to the content-based group state that the way screen media influence a child's development mainly depends on media content (Scarf & Hinten, 2018). Such theories predict that media providing educational content and showing examples of appropriate behavior may have a positive impact on viewers, while media

with examples of inappropriate, e.g., violent behavior, influence viewers negatively (Anderson et al., 2001). Despite official recommendations, screen-based media aimed at the youngest viewers has been available for a while now, promising content that will help young children learn and facilitate their development (Rideout, 2021). However, the true benefits behind this type of media aimed at specific age groups, often described as „educational", need more prove (Cerniglia & Cimino, 2020).

2.1.1. Content comprehension and child-aimed media

Some theories from the content-based group, i.e., observational learning theory and information processing theories, predict that children attend to, encode, and store in memory information from media to which they were exposed, especially from media aimed at their age group (Anderson et al., 2001; Bandura, 1994). However, as studies have shown, such young children can learn by being exposed to screens, but this learning is very limited (DeLoache et al., 2010; Pempek et al., 2010; Vandewater, 2011). Many cognitive factors play a role in learning from content presented on screens including children's developing perceptual systems, understanding of symbols and analogy (i.e., dual representation abilities), and abilities to discriminate the trustworthiness of sources (Richert et al., 2010). These capabilities are not fully developed yet in children younger than 2 years, who have a limited understanding of the content on 2D screens (Radesky et al., 2016a, 2016b, 2016c). In addition, as one study suggests, also sequential and linguistic comprehension of commercially-produced videos occurs no earlier than the middle of the second year of life (Pempek et al., 2010). Transfer of learning between 2D and 3D contexts develops slowly during early childhood; thus, very young children are not always capable of comprehending the relationship between what they see on a screen and reality (Barr, 2010, 2013; Zack et al., 2013; Ziemer & Snyder, 2016). Despite being able to imitate observed actions and learn baby-signs from a video (Dayanim & Namy, 2015), such young children do not seem to view videos as relevant to real life and cannot acquire new knowledge from screens without proper guidance (Radesky et al., 2016a, 2016b, 2016c). Only as they get older and enter a preschool period, do children start showing a better understanding of media content and they can learn more from it (Barr, 2010; Krcmar, 2014). Researchers suggest that young children's difficulty with the dual representational nature of screens can be one reason why such young children are not able to learn from videos, called the "video deficit effect" (Barr, 2010; Sheehan & Uttal, 2016a).

Apart from the ability to learn, screen-based media can affect children's executive functions (Barr, 2010; Huber et al., 2018; Hughes & Devine, 2019; Lillard & Peterson, 2011; Linebarger et al., 2014; McNeill et al., 2021; Nathanson et al., 2014). Better-developed executive functions are positively associated with academic achievement and later-life health and well-being. Core executive functions include inhibition and interference control (selective attention and cognitive inhibition), working memory, and cognitive flexibility (Diamond, 2013). Experiences during infancy and toddlerhood can already affect the development of executive function abilities (Barr, 2010; Radesky et al., 2016a, 2016b, 2016c). Exposure to child-oriented content, such as child-oriented educational cartoons, reflected in children's intentional screen viewing, has been shown to be negatively related to executive functions among preschoolers (Nathanson et al., 2014). As the authors argued, the addition of educational content to cartoons could lead to overstimulation, which then results in weaker executive functioning. Nevertheless, this study did not report on the impact of screen-based media on specific executive function abilities. Investigating changes in different executive functions in relation to screen-based media use may be of importance, since, as another study showed, there can be an improvement in 2–3-year-old children's working memory after playing an educational app (Huber et al., 2018). The study highlighted that for the development of executive functions in young children, interactivity and content of programs for children can be important factors. Similar observations were presented by McHarg et all. (2020), whose findings from a study with infants support the notion that interactivity, as well as content-specific exposure, may make an impact. Such contradicting findings show that more research on the relation between screen-media content and different executive functions is needed. Especially, since children do not only view and interact with child-aimed content but are also exposed to adult-aimed content via background exposure.

2.1.2. Interactive content

The development of touchscreen devices, such as smartphones or tablets, and apps, and the increase in their popularity, lead researchers to investigate their potential for early childhood education (Xie et al., 2018). Some touchscreen apps have been specifically designed for educational purposes and children as young as 5 months use interactive screens, which shows that interactive screen use is present at a very early stage in a child's development (Cristia & Seidl, 2015). The interactive content of screen-based media and active engagement in performed tasks have been shown to facilitate learning and language development in young children (Barr, 2010; Fidler et al., 2010; Huber et al., 2016; Kirkorian, 2018; Lovato & Waxman, 2016b; Lytle et al., 2018; Mendelsohn et al., 2010; Russo-Johnson et al., 2017; Sheehan & Uttal, 2016a; Strasburger, 2015; Strouse & Troseth, 2014; Wang et al., 2016) and to be beneficial to working memory (Huber et al., 2018). For example, some evidence suggests that 24–36-months old children can learn better from touchscreen devices than from television, which has been described as more passive viewing (Kirkorian et al., 2016).

Interactive screen content may support learning by directing attention to relevant information presented on screens and holding children's attention. However, the influence of interactive content of screen-based media on children's early development can be moderated by factors, such as a child's age, comparison group, or experimental environment (Xie et al., 2018). For example, children at various stages can learn differently from interactive content, with younger children requiring additional support through social contingency. Social contingency, which is a fundamental part of the regularities in human speech, can help very young children to learn and overcome the video deficit effect (Kucker, 2021; Roseberry et al., 2014a,2014b). Without the presence of social contingency, learning outcomes are reduced (Choi & Kirkorian, 2016; Courage, 2017; H. Kirkorian et al., 2016; Myers et al., 2018). It has been shown that children learn better from live or on-screen humans than from on-screen robots (Sommer et al., 2021). The importance of interactivity, especially on-screen human interactivity, for language development was also highlighted in a study by Roseberry et al., (2014a,2014b). In this study, children between 24 and 30 months only learned novel verbs in live interaction and video chat training,

but not through non-interactive video training (Roseberry et al., 2014a, 2014b). Nevertheless, despite a large number of studies on the interactive content of screen-based media on young children's learning and language development, more research is needed to understand the impact of interactive screen-based media on other aspects of children's development, e.g., executive functions or emotion regulation.

2.1.3. Background exposure

Exposure to screens takes place across various situations, such as daily routines, meals or playtime, interacting with a family member, or even sleeping (Raman et al., 2017). Children younger than 24 months may be under an influence of 5–6 h of background screen time and noise daily, which can have a negative effect on their cognitive development as well (Lapierre et al., 2012). During such background exposure, children's attention is often directed not only to child-directed content but also to adult-directed one. In a prospective cohort study, researchers compared the effects of exposure to child-directed on executive function performance with exposure to adult-directed programs (Barr, 2010). In this study, parents completed viewing diaries when children were 1 and 4 years old. Parents also assessed children's executive functions by completing a questionnaire when their children were 4 years old. Results indicated that watching adult-oriented content in infancy was associated with poorer executive function at age 4. Additional measurements of cognitive abilities at age 4 and controlling for parental education revealed that high exposure to adult-aimed content was associated with poorer language and school readiness skills, and lower scores on executive functions. Such negative outcomes were not observed when children were exposed to child-aimed programs.

The reason behind the effects of background exposure and adult content on young children's executive functions may lie in the ability to control attention in such young children. Skillful control of attention plays an important role in selecting relevant information from the environment and creates a ground for the adaptive control of behavior early in life (Cohen, 2014; Hendry et al., 2016; Portugal et al., 2021; Rothbart et al., 2011). Stimulus-driven (exogenous) and goal-driven (endogenous) processes interact to make the selection of relevant information possible and they can be influenced by screen viewing (Courage, 2017; Nikkelen et al., 2014). Background exposure has been described as having attention-getting (whether and how quickly children orient to a stimulus), but not attention-holding (the duration children look at the stimulus once fixated) properties (Courage & Setliff, 2010). Because adult content is incomprehensible to young viewers, attention to screens is not sustained. Thus, exposure to background television is thought to indirectly disrupt cognitive processing through its creation of disorganized settings where a child's attention is constantly recruited away from performed tasks. For example, a longitudinal study by Setliff and Courage (2011) investigated a relationship between background television and infants' attention during a period of free play with an array of novel toys. At 6 months, and then at 12 and 24 months of age, infants were assigned to different groups and were exposed to a 10-minute television program. During each TV-viewing session, children were also given toys to play with and several measures of visual attention were calculated to reflect infants' attention to toys and television when the television was on and when it was off. The results indicate that infants at both 6 and 12 months of age showed a preference for looking at and playing with toys over looking at television. However, infants' preference for toys was strongly affected by the order in which a television program was presented. Analysis of infants' focused attention to toys showed more focused attention at 12 months in comparison to 6 months of age. A follow-up of the infants at 24 months indicated greater resistance to distraction by television during play. Even though television did not seem to engage infants' attention, it disrupted toy play activities (Setliff & Courage, 2011). Such continual attention variation is hypothesized to result in more persistent difficulties in executive functions later on and interference with the development of good attention skills (Ackerman & Brown, 2010; Anderson & Hanson, 2010; Barr, 2010; O'Toole & Kannass, 2021; Setliff & Courage, 2011).

The presence of background television during parent-child play situations can negatively affect vocabulary acquisition for children just under 2 years old (Masur et al., 2016). If a parent is distracted by television viewing, he or she interacts less with a child, lowering the chances of learning new words by a child. Background television can reduce the overall number of words spoken and utterances per minute by parents (Pempek et al., 2014). Even when parents and children attend to television together, their communication is less frequent, than when they engage in a book reading or toy playing (Hanson et al., 2021; Nathanson & Rasmussen, 2011). Finally, having screens on in the background and viewing inappropriate content can reduce social interaction and negatively impact the development of prosocial behavior and emotional regulation abilities in young children (Chonchaiya et al., 2015; Conners-Burrow et al., 2011; Jackson, 2018; Lin et al., 2020; Oflu et al., 2021; Poulain et al., 2018; Radesky et al., 2014). The content present in background screen-based media often portrays violent and aggressive behavior. Young children exposed to such content may show less empathy for people in difficult situations, and experience more fear, or antisocial behavior later in life (Fitzpatrick et al., 2012, 2016). Overall, as the above results show, background exposure to screen-based media and adult-oriented content, can impair young children's language and attention skills, disrupt play and learning activities, and negatively influence social interactions. Thus, parents and caregivers should avoid having screens on in the presence of young children, especially when screen content is adult-oriented.

2.1.4. Prosocial media content

An important aspect of screen-based media is their potential contribution to socioemotional learning. Research on prosocial media effects investigated the relationship between exposure to prosocial screen-based media and the development of behaviors like honesty, helping others, generosity, friendly attitudes towards others, or aggression reduction (Mares et al., 2022; Mares & Stephenson, 2017; Peebles, 2020; Peebles et al., 2018). Different types of prosocial behavior develop rapidly in the second year of life. However, toddlers who express one type of prosocial behavior, e.g., sharing with others, may or may not necessarily show other prosocial behaviors, e.g., comforting others (Brownell, 2013). Social experiences during early childhood, like exposure to prosocial media, may affect the development of particular prosocial behavior. Children's prosocial shows incorporate moral lessons in their narratives, but research suggests that children may have difficulties comprehending these lessons (Mares et al., 2022). As very young children are not fully able

to distinguish fantasy from reality (video deficit effect) they are likely to imitate behavioral patterns shown on screens (Ostrov et al., 2013). Furthermore, pre-school children may struggle with perspective-taking, as their cognitive abilities are not developed well enough for such a skill (Jean Piaget, 1965). Mares et al. (2022) ran two studies with pre-school children (3–5 years old) to explore strategies for children's prosocial media effects. In Study 1 (N = 107), two paths to prosocial behavior were explored – one through the comprehension of the intended lesson and the other though affiliative priming of attachment security. For 7,5 min children watched a prosocial narrative (helping vs. waiting) with affective primes (loving vs. funny) or a control narrative. The results showed that comprehension among preschoolers was low and behavioral outcomes were unaffected by lesson or prime. In Study 2 (N = 64), preschoolers watched shorter, 1-minute song videos about loving or helping others. Children assigned to the helping condition were more prone to help, while those in the loving condition did not differ from the control group (no exposure). As young children struggle to understand moral narratives, simplifying lessons by reducing media length and adjusting content can improve comprehension of messages sent by prosocial media (Mares et al., 2022).

Nevertheless, young children are able to notice when fairness is violated or when someone is getting harmed, and they show a preference for prosocial acts rather than antisocial ones (Cingel & Krcmar, 2017; Geraci & Surian, 2011). Moreover, parental mediation and supervision during screen-based media exposure can help very young children to understand the content better and transfer what they see on screen to a new situation. For example, in their study, Rasmussen et al. (2016) investigated the relation between active mediation, exposure to an educational, child-aimed program (*Daniel Tiger's Neighborhood*), and preschoolers' socioemotional development. Here, 2–4-year-old children and their parents were divided into 4 groups (active mediation condition, co-viewing condition, viewing alone condition, and control group). The first 3 groups were instructed to watch the program over two weeks. Those assigned to a control group watched a nature-themed documentary program. After two weeks, children participated in a series of tasks to measure self-efficacy and emotion recognition. The study found that watching an educational show like *Daniel Tiger's Neighborhood* was associated with higher levels of empathy, but only for preschoolers who received frequent active mediation from parents.

To sum up, even though a large number of programs are described as infant-friendly, many young children do not have the ability to comprehend their content and learn from them (Radesky et al., 2016a,2016b,2016c). Even for children at pre-school age, educational and child-aimed content may be detrimental to children's cognitive functioning, though here, findings have been mixed (Huber et al., 2018; Nathanson et al., 2014). Interactions between young children and their parents can also be affected by the presence of screen media, especially during background exposure to adult-oriented content (Pempek et al., 2014), resulting in weaker language and attention skills. Nevertheless, well-designed and educational programs with age-appropriate features may help children to learn antiviolence attitudes, empathy, tolerance, and respect (Ponti et al., 2017). However, positive effects on young viewers require active mediation from parents (Mares & Stephenson, 2017).

2.2. Early development and screen-based media within content-independent theories

Another set of theories focuses on content-independent aspects of screen-based media. Content-independent theories, such as time-displacement theory, state that the influence of screen media takes place irrespective of content children attend to, for example in such a way that exposure to media replaces other activities, like reading and social interactions, which positively influence a child's intellectual development (Scarf & Hinten, 2018). Screen-based media can be very attractive to young children and extensive early exposure to them can lead to negative habits of time use, i.e., preferring activities that are intellectually and physically passive, and can negatively influence cognition (Anderson et al., 2001; Madigan et al., 2019). Here, time spent in front of screens or the age at which a child has the first encounter with screen-based media has been investigated as factors that have a strong effect on children's cognition (Kerai et al., 2022; Madigan et al., 2019; Supanitayanon et al., 2020).

2.2.1. First-time exposure

Some research findings argue that age and time of first exposure to screen media may be important factors affecting children's cognition and ability to learn from screen viewing (Supanitayanon et al., 2020). Earlier age of onset of screen media exposure may lead to decreased preschool cognitive performance, e.g., weaker executive functions or attention difficulties (Nathanson et al., 2014; Supanitayanon et al., 2020). In a large longitudinal study, McHarg et al. (2020) looked into links between regular, early exposure to screen-based media and performance on cognitive tests. As a part of a comprehensive questionnaire, parents were asked to report the duration their 4-months-old infant was exposed to screen-based media. At 14 months, toddlers completed a short series of tasks; Prohibition task for inhibition, Three Boxes task for working memory, Ball Run task for cognitive flexibility. Results showed that screen exposure at 4 months was negatively associated with inhibition at 14 months of age. No relation between screen-based media use and either working memory or cognitive flexibility was observed (McHarg et al., 2020). The outcomes of this study add to previous literature (Barr et al., 2010; Lillard & Peterson, 2011) by suggesting longitudinal links between early screen exposure and inhibition. As pointed out, the association between early screen exposure and inhibition was found over and above parent characteristics, such as mental health problems or couple conflicts. Finally, early first-time exposure to screens can contribute to the total cumulative amount of time children spend exposed to screens. As we show in the following section, excessive screen time can also be associated with children's developmental delay (Lin et al., 2015; Madigan et al., 2019).

2.2.2. Quantity of screen-based media

Despite official recommendations on screen time presented by WHO and AAP, screen-based media exposure has been increasing in young children (Kaur et al., 2019). For example, children younger than 2, engage with screens for an average of 49 min a day (Smith,

2020). Children with developmental delays tend to spend more time viewing screens than children without developmental delays (Lin et al., 2015). However, the direction of this relationship is not clear. As some results indicate, higher exposure to screens can be an initial factor leading to developmental delays. In their longitudinal study, Madigan et al. (2019) observed that greater screen time was associated with poorer performance on the Ages and Stages Questionnaire (ASQ-3), which identifies developmental progress in 5 domains: communication, gross motor, fine motor, problem-solving, and personal-social. Specifically, the group observed that children who spent more time exposed to screens at 24 months and 36 months had lower scores on ASQ-3 at 36 and 60 months respectively (Madigan et al., 2019). Furthermore, higher person-level means on the ASQ-3 were observed for girls and when mothers reported lower maternal depression and higher income, maternal positivity, levels of child physical activity, child reading activity, and hours of sleep per day. These results suggest that both screen exposure and performance of developmental screening tests can be associated with factors like family income, maternal depression, child sleep, a child being read to regularly, and a child's sex.

Studies, focusing on the links between screen media use and children's executive functions, suggest that higher screen time may be related to poorer executive functions in preschool children (Barr, 2010; Nathanson et al., 2014). Nathanson et al. (2014) showed that children who had spent a greater number of cumulative hours viewing television had poorer executive functioning than children who had viewed fewer cumulative hours. In another study, McNeil et al. (2021) recruited pre-school children (3–5 years of age) and used parents' reports on the total number of screen-based devices in a house and those that were available to their children to assess executive functions development in preschoolers. Executive functions were assessed using measures that were psychometrically validated in a pre-school age group. Findings showed some significant associations. Specifically, visual-spatial working memory was lower at higher levels of total screen media use and television program viewing, while high-dose app users display better phonological working memory than non-users (McNeill et al., 2021). Such findings suggest that different types of screen-based media affect executive functions differently.

It is also important to take demographic and home environment factors into account while investigating the association between the quantity of screen exposure and changes in executive functions. In their study, Linebarger et al. (2014) assessed a group of pre-school children and their exposure to background and foreground television. Within this study, participants were categorized into low and high-demographic risk groups, and parents reported on children's screen exposure using a 24-hour diary. Results showed that higher exposure to background television in pre-school children at high demographic risks was associated with weaker executive functions, while foreground exposure to entertainment programs predicted higher executive functions in low demographic risk children (Linebarger et al., 2014). In another study, Blankson et al. (2015) examined the relationship between the amount of television exposure at ages 3 and 4 and vocabulary and executive functions at age 5. By using performance-based cognitive measures, the quality of a home learning environment, and the quantity and quality of parent-child interactions, the researchers observed a negative correlation between the amount of television viewing and the quality of a home learning environment and social interactions. The initial association between television viewing at age 3 and executive functions and vocabulary at age 5 was no longer significant when researchers controlled for home and family cognitive support (Nayena Blankson et al., 2015). Similar observations were made between screen exposure at age 4 and executive functions and vocabulary at age 5. The only significant associations were detected between parental support and vocabulary. These results show that parental support is crucial in reducing the negative effects of screen-based media on young children's development.

Research findings on an association between screen time and problems with attention are mixed. Some evidence has been presented for positive cross-sectional links between increased screen time and attention difficulties in early childhood (Tamana et al., 2019). Specifically, exposure to more than two hours of screen time was associated with an increased risk of inattention problems. Nevertheless, other evidence from longitudinal research investigating associations between screen time and problems with attention over time, showed that there is almost no association between television watching during toddlerhood and attention problems later on (Galetzka, 2017). Minor attention difficulties were observed only for children who watched over 7 h of television. These findings suggest that exposure to television in early childhood may be detrimental to attention, but only at very high levels of exposure (Lerner & Barr, 2015).

Higher screen time interferes with opportunities to learn and actively engage in family life, but an increased time of screen exposure can be also influenced by children's difficult behavior. Parents who do not know how to handle such difficult behavior, place their infants and toddlers in front of screens (Radesky et al., 2014). Radesky et al. (2014) observed that infants with self-regulation problems watched 9 min per day more media at age 2, compared to infants with no or mild self-regulation problems, while persistently difficult toddlers were 40% more likely to spend more than 2 h of their day in front of a screen. Furthermore, young children who spent more time attending to screen media, are more likely to have socioemotional problems, anxious and depressive symptoms, social withdrawal symptoms, and show aggressive behaviors (Cliff et al., 2018; Desmarais et al., 2021; Lin et al., 2020; Wan et al., 2021). The impact of a high usage level of screen-based media on socioemotional development may differ between very young children and pre-school children. As one study showed, an increased quantity of screen exposure at 18 months of age was not associated with problems in psychosocial well-being later on (Niiranen et al., 2021). The authors, however, found that excessive screen use at age 5 was associated with attention and concentration difficulties, hyperactivity and impulsivity, emotional internalizing and externalizing symptoms, and conduct problems (Niiranen et al., 2021). As the authors point out, parents may regulate children's media usage habits in younger children, which can contribute to differences in psychosocial well-being outcomes between toddlers and preschool children.

Overall, earlier first-time exposure and high exposure to screens during the first five years of life can lead to poorer executive functions and possible attention difficulties, as well as delays in language development (Lin et al., 2015; Supanitayanon et al., 2020). It can also negatively impact socioemotional development and result in behavioral problems (Radesky et al., 2014). However, the findings described above, have shown that the extent to which high screen exposure affects cognitive and socioemotional development may differ, with some studies reporting significant findings and others only minor impact (Galetzka, 2017; Lerner & Barr, 2015;

Nathanson et al., 2014). The reason behind these differences can be attributed to various contextual factors, which may influence a child's susceptibility to excessive screen time (Madigan et al., 2019), while, as previously described, inappropriate content can also be an important variable to consider (Barr, 2010).

2.3. Early development and screen-based media within form-based theories

Screen-based media and programs, especially those recently developed, aimed at young children are often designed to attract children's attention and appear as something parents should select for their children. Form-based theories concentrate on specific features of screen media, such as pace (i.e., scene changes and movements) or visual and auditory effects, which may differ in the way they impact children's cognition, intellectual processing, or behavior (Anderson et al., 2001). Certain screen-based media characteristics can help young children better understand media content, including using familiar social characters, using simple tasks, or directing a child's attention to important information via auditory and visual cues (Lauricella et al., 2011). Various features can affect optimal cognitive development in early childhood (Lillard, Drell, et al., 2015; Lillard, Li, et al., 2015; Lillard & Peterson, 2011; Nathanson et al., 2014), which we address in the following sections.

2.3.1. Screen-based media pace

Programs directed at young children often provide "nonnormative stimulation", which is characterized by the rapid pace and atypical sequencing, which may be disadvantageous for cognition and behavior (Kirkorian et al., 2012; Nathanson et al., 2014). For example, the frequency of scene changes or cuts (media pace) may influence aspects of executive functions (Lillard & Peterson, 2011; Scarf & Hinten, 2018). One study showed that just 9 min of viewing fast-paced television cartoons had immediate negative effects on pre-school children's executive functions relative to watching an educational program or drawing (Lillard & Peterson, 2011). As the authors explained, the rapid pace and fantastical nature of a cartoon may have exhausted children's cognitive reserves and weakened executive functioning performance. Furthermore, watching programs interrupted by commercials may be even more detrimental to a child's executive functioning (Lillard & Peterson, 2011). Commercials disrupt a storyline, bring confusion, and force children to constantly disengage and re-engage in watched programs. In a later study, Lillard, Li, et al. (2015) also showed that children at 4 years of age had impaired executive functions after watching fast and fantastical shows, relative to that of children who watched a slow, realistic show or engaged in play instead. Viewing rapidly-paced shows can be very demanding to a child's working memory. Each time a new scene appears on a screen, a child needs to encode new information. In the case of fast-paced programs, the number of novel information children need to attend to and encode, can lead to the overloading of children's working-memory capacity and reduced performance on tasks assessing executive functioning right after screen viewing (Lillard, Li, et al., 2015).

2.3.2. Visual and auditory effects

Other important characteristics of children-aimed screen-based media include visual and auditory features. Various screen media, such as videos, apps, and games, can effectively attract children's attention through their sensory and perceptual features, e.g., bright colors or cheerful music (Anderson & Hanson, 2010). Studies investigating the role of visual and auditory features of screen-based media primarily focused on learning and language development (Flynn et al., 2019; Neuman et al., 2019). As these studies show, such features, together with child-appropriate content, can support learning from screens and influence vocabulary. In the absence of dialogue, visual images and sound effects can help children comprehend onscreen stories and interpret the meaning of viewed programs (Flynn et al., 2019). Despite certain positive effects on learning, visual and auditory modalities in child-aimed programs are often very dominating, which creates a risk for the development of other modalities, like tactile, proprioceptive, or visceroceptive modalities (Suggate & Martzog, 2020). Exposure to a high number of sensory inputs, together with fast pace or distractions from commercials, can potentially overstimulate developing brains and be harmful to the development of executive functions in young children (Lillard & Peterson, 2011; Vedechkina & Borgonovi, 2021). Nevertheless, there is still a limited number of publications including visual and auditory effects as the variables affecting a child's cognitive development. As both types of sensory effects are very prominent in screen-based media, future research should include visual and auditory screen characteristics in their methodology and investigate the role of visual and auditory effects in combination with other screen-based media characteristics on child development.

2.3.3. Formal features

Despite the official recommendations, programs aimed at young children contain features unsuitable for a young audience, which require cognitive skills that are still underdeveloped in young children. To reduce cognitive load and improve story comprehension, various features can be implemented into apps and programs. For example, programs that incorporate simple story schema and have clear connections among events can be less demanding for working memory than complex characteristics of on-screen stories (Fisch, 2000). Furthermore, incorporating early cues, such as previews, or narrative inserts in the middle of a program, provides an organizational structure and may help reduce the demands of processing on-screen content. Such characteristics are described as advance organizers. In his Capacity Model, Fisch (2000) explains that advance organizers can support children's comprehension of both educational and narrative content. Advance organizers can guide young viewers and point to relevant and central information in the programs' narrative, facilitating learning in both cognitive and socioemotional domains.

By providing previews, young children are given a chance to have a general overview of concepts presented on screens, which will be repeated later on. Such repetition increases familiarity and learning from educational programs (Jing & Kirkorian, 2020; Krcmar, 2010). In their study, Jing et al. (2020), examined the impact of summary previews on preschoolers' comprehension of an educational program. Three to five years old preschoolers were randomly assigned to one of three conditions: a control group without a preview, an

education-focused expository preview group, and a story-focused narrative preview group. As researchers highlighted, some types of previews may be more beneficial than others. The results indeed indicate that the story-focused narrative preview promoted comprehension of both narrative and educational content. When compared to the no-preview control group, children in the education-focused expository preview group did not show an increase in content comprehension (Jing & Kirkorian, 2020). Nevertheless, further studies are needed to assess the optimal set up of previews and their order in a storyline.

Another feature involves including a socially-meaningful character in a storyline, which can also facilitate early learning by forming an emotional connection between a young viewer and a media character. Meaningful on-screen actors, such as mothers, are recognized by young children as familiar and trustworthy characters who those children previously learned from (Krcmar, 2010). Including a familiar character can also decrease cognitive load, as it eliminates the need for young children to interpret who the new character is. A study among 21-month-old toddlers showed that children who observed a task performed by a socially meaningful character learned and performed the same task better than children who observed the task presented by a less socially meaningful character (Lauricella et al., 2011). Familiar and socially meaningful characters could also guide young viewers towards prosocial behavior and help them understand the behaviors presented on screens, potentially improving socioemotional development.

2.4. Early development and screen-based media within social-based theories

Literature shows that parents are often unaware of the official guidelines of the AAP or WHO and that they are rarely informed by medical practitioners about the effects of mobile devices on their children. Most parents are not familiar with the adverse consequences associated with children's exposure to screens (Beck et al., 2015; Golden et al., 2020; Haines et al., 2013; Kılıç et al., 2018). Often, parents believe that exposing children to apps or programs which are described as child-friendly and educational can bring benefits to their child's cognitive and socioemotional development (Bentley et al., 2016; Kostyrka-Allchorne et al., 2017; Li et al., 2018). There are also other reasons why parent place their children in front of screens, including the need to regulate a child's distress, reward good behavior and punish bad ones, or create time for themselves and their own activities (Gordon-Hacker & Gueron-Sela, 2020; Hawi & Rupert, 2015; Kabali et al., 2015; Kılıç et al., 2018; Radesky et al., 2016a,2016b,2016c; Vaala & Hornik, 2014).

Recent studies highlighted the importance of parental behavior in shaping their children's relationship with screen-based media and reducing the negative influence of screen viewing on a child's development (Chindamo et al., 2019; Elias & Sulkin, 2019; Lauricella et al., 2015; Lederer et al., 2021; Nevski & Siibak, 2016; Nikken & Schols, 2015). The notion that the behavior of parents as role models and parental mediation can play a role in modulating the effects of screen-based media on cognitive and socioemotional development can be placed under a social-based theories umbrella. In the following sections, we describe how literature findings contribute to these theories and we highlight concepts such as technoference, co-viewing, and joint media engagement. We also include video-chatting here, as video chats became the common means of communication, especially recently in the situation of isolation due to the COVID-19 pandemic, and they can be good sources of learning social skills.

2.4.1. Parents as role models

Infants and toddlers closely observe their parents' behavior towards screen-based media and use these observations to create their own habits (Lauricella et al., 2015). If parents frequently attend to screens in front of their young children, those children will likely appear interested and try to copy this behavior, e.g., by picking up a phone or look-alike toy and pretending to have a call. Yet, such behavior can be misleading and does not indicate that such young children can comprehend their actions and are capable of learning from the information presented on a screen (Anderson & Hanson, 2010). Furthermore, parents who use screen media more often may show more positive attitudes toward screen exposure and be more willing to teach their children how to use screen-based media (Chindamo et al., 2019). Heavy use of digital technologies by parents, such as mobile devices, can lead to poorer verbal and non-verbal parent-child interactions, which are crucial for children's optimal cognitive and socioemotional development (Gordon-Hacker & Gueron-Sela, 2020; Radesky et al., 2015a,2015b). When highly occupied with mobile devices, parents do not respond efficiently to their children's needs, and reciprocal social interactions with their children are disturbed (Kildare & Middlemiss, 2017). These interactions are a primary socialization mechanism for the development of attention skills and if they are disturbed, children are losing a chance to practice emerging focused attention abilities (Gueron-Sela & Gordon-Hacker, 2020).

Parents themselves spend on average 9 h per day using screen-based media for various purposes (Wartella et al., 2014). Recently, the term "technoference" has been introduced to describe everyday interruptions in interpersonal interactions or time spent together that occur due to digital and mobile technology devices (Corkin et al., 2021; McDaniel & Radesky, 2018a; McDaniel & Coyne, 2016; McDaniel & Radesky, 2018b). Technoference can greatly reduce the quality of daily parent-child interactions, resulting in a child's psychosocial difficulties and higher involvement with screens (Krogh et al., 2021; Wong et al., 2020). A cross-sectional association was observed between interference from parent technology use and higher child externalizing behavior problems (e.g., tantrums, emotional reactivity) and internalizing behavior problems (e.g., anxiety, withdrawal) (McDaniel & Radesky, 2018a). Further investigations suggested bidirectional dynamics in which (1) parents become stressed by their child's difficult behavior and want to withdraw from parent-child interactions by using screen-based media and (2) this higher screen media use during parent-child interactions may influence externalizing and withdrawal behaviors over time (McDaniel & Radesky, 2018b). Similar findings were reported in a recent study by Shin et al., who showed that higher negative affectivity and lower effortful control in toddlers were associated with higher maternal parenting stress, which in turn was related to greater screen use in toddlers (Shin et al., 2021). In another study, McDaniel and Radesky (2020) also found that greater child externalizing behavior predicted greater parenting stress, which then predicted increases in child screen media use. Nonetheless, child media use did not predict later externalizing behavior (McDaniel & Radesky, 2020).

Parental attendance to screen-based media was also found to significantly predict attachment insecurity, while children's high use of television was associated with poorer attachment security (Linder et al., 2021). Thus, the AAP gives recommendations to parents to reduce their media use while taking care of a child and engage in interactions without screens presences (Radesky et al., 2016a,2016b, 2016c). Parents can also implement several mediation techniques, which can help reduce the negative effects of screen-based media.

2.4.2. Parental mediation

Some parents show concern about the use of screen-based media by very young children (Brown & Smolenaers, 2018; Connell et al., 2015). Nevertheless, not all parents set strict rules regarding screen time, the type of viewed content, or under which circumstances screen-based media are viewed by their children, and some parents struggle to do so (Arumugam et al., 2021; Golden et al., 2020). Parental mediation is defined as any strategy parents use to control, supervise or interpret media content for children (Nikken & Opree, 2018). Controlling children's screen time and the screen-time rules set at home can be beneficial for children's cognitive and socio-emotional development (Elias & Sulkin, 2019; Lederer et al., 2021; Nevski & Siibak, 2016; Nikken & Schols, 2015). There are different forms of parental mediation. Restrictive mediation is when parents set rules regarding allowed content or time spent viewing screen media, while active mediation refers to parent-child discussions about screen media use and the onscreen content, to facilitate learning (Nikken & Schols, 2015). Furthermore, parents may decide to co-use screen media with children together, for example for entertainment or to increase chances for parent-child interactions (Pempek et al., 2011). By actively participating in co-viewing and co-using, referred to as joint media engagement, screen-based media with their very young children, parents also help them with comprehending what is happening on screen, directing their attention to relevant content, and recognizing onscreen emotions (Archer et al., 2021; Coyne et al., 2017; Rasmussen et al., 2016; Strouse & Ganea, 2021). Indeed, preschoolers who watched a television program for children showed good emotion recognition, empathy, and self-efficacy, but only when their regular television-watching experiences were accompanied by active parental mediation (Rasmussen et al., 2016). Furthermore, if, during the co-viewing of educational programs, parents follow up on a child's focus of attention at a specific moment, described as a contingency, and are sensitive to a child's attempt to interact, recognize a child's needs and respond to these needs accordingly, described as responsiveness, children can show better attentiveness and learn new vocabulary more efficiently (Alroqi et al., 2022; Myers et al., 2018; Strouse et al., 2018).

Sometimes parents use screen-based media to regulate their child's distress (Gordon-Hacker & Gueron-Sela, 2020). In their study, Gordon-Hacker and Gueron-Sela (2020) examined longitudinal links between the use of screen media to regulate distress and children's negative emotionality during toddlerhood. Children were assessed at 18 and 26 months of age. The results showed that maternal use of media to regulate a child's distress was positively related to increases in children's negative emotionality, but only for children with initially low negative emotionality, and not for children with initially high negative emotionality (Gordon-Hacker & Gueron-Sela, 2020). Very young children have limited self-regulatory abilities and they primarily seek parental guidance on how to modulate their emotions (Sameroff, 2010). If young children experience negative emotions and receive unsupportive responses from parents, they can experience difficulties with focusing and shifting as well as controlling their attention (Spinrad et al., 2007). Therefore, AAP recommendations discourage using screen-based media to regulate children's difficult distress, as such a solution can potentially affect the development of children's self-regulation skills (Radesky et al., 2016a,2016b,2016c).

2.4.3. Video chatting

The development of new screen media, such as smartphones, makes it easier to maintain connections with family members and friends who are far away. Video chatting is also one of the first sources of media children under the age of 2 experience and it has been assessed more positively by parents than other types of screen media (McClure et al., 2015). Current WHO and AAP screen time recommendations make a positive exception for video chatting in their screen-time guidelines. However, there has been evidence indicating that this form of screen exposure can be confusing for the youngest users. Without adult guidance, they may struggle to interpret communicative cues from videos (Strouse et al., 2018). Nevertheless, children in their second year are able to form social connections and learn new content from video chats, such as FaceTime, though it may be not as much as from live, direct face-to-face interactions (Myers et al., 2017, 2019). FaceTime settings create social contingency with children's behavior and interactive video chat can be a medium for learning and social relationships in the second year (Myers et al., 2017).

In summary, children look up to their parents for guidance through the first years of their life. As first role models, parents should teach their children how to use screen media in balanced, positive ways, to create a healthy media use environment. One way parents can do that, is to monitor their own time they spend using screen-based media, especially in front of children. They also should supervise children's media habits and apply different mediating techniques to regulate the impact of screen-based media on their children's development. The form of mediation parents decide to use, should be adapted to the developmental stage of a child (Clark, 2011). Younger children may need more guidance and stricter rules from their parents to effectively learn from screen-based media and develop a healthy relationship with screens.

3. Discussion

Nowadays, screen-based media is an inevitable part of young children's life. For those under the age of five, exposure to screens can pose risks and some benefits as well. In this review, we primarily focused on different characteristics of screen-based media and the potential impact of screen media exposure during the first five years of a child's life on cognitive and socioemotional development. Research outcomes reported in this review underline several important aspects of screen-based media use by young children. First, over the past decade, and especially during the COVID-19 pandemic lockdowns, there has been an increased use of screen-based media

by children up to the age of five (Bergmann et al., 2022; Chen & Adler, 2019; Kabali et al., 2015; Madigan et al., 2020). Second, for children younger than two years there is a video deficit effect, and such young children are not able to form links between what they see on a screen and reality (Pempek et al., 2010; Radesky et al., 2016a,2016b,2016c; Radesky et al., 2016a,2016b,2016c; Yadav et al., 2018). To acquire new knowledge from screens, they need proper guidance from their caregivers (Radesky et al., 2016a,2016b,2016c). Third, excessive screen use, watching inappropriate and fast-paced content, unsupervised screen exposure, and no parental involvement are disruptive to a child's executive functions, development of attention skills, learning, and language development, and parent-child interactions (Lillard & Peterson, 2011; McDaniel & Radesky, 2018a; Radesky et al., 2016a,2016b,2016c; Scarf & Hinten, 2018). Finally, the negative effects of screen-based media exposure can be reduced by exposing children to carefully selected content with features that are appropriate to their age and cognitive abilities. Specifically, programs that will actively engage children, contain visual and auditory cues, and are not interrupted by commercials, can facilitate learning and be beneficial to working memory and attention skills (Barr, 2019; Fidler et al., 2010; Huber et al., 2016, 2018; Kirkorian, 2018; Lovato & Waxman, 2016a; Lytle et al., 2018; Mendelsohn et al., 2010; Russo-Johnson et al., 2017; Sheehan & Uttal, 2016b; Strasburger, 2015; Strouse & Troseth, 2014; Wang et al., 2016).

The majority of studies reporting on the impact of screen-based media use on young children's development has been correlational, cross-sectional, or based on self-reports from parents (Jusienė et al., 2020; Linebarger et al., 2014; Przybylski & Weinstein, 2019). Only a few longitudinal studies have been conducted (Dayanim & Namy, 2015; DeLoache et al., 2010; McDaniel & Radesky, 2020; Supanitayanon et al., 2020). There has been a lot of focus on the use of old screen media, like television or DVDs (Courage & Setliff, 2010; DeLoache et al., 2010; Lillard, Li, et al., 2015; Lin et al., 2015; Pempek et al., 2010), including background exposure (Lapierre et al., 2012; O'Toole & Kannass, 2021; Pempek et al., 2014; Setliff & Courage, 2011), though recently, an increasing number of studies assessing newer forms of screen media, such as tablets and smartphones, have been published (Bentley et al., 2016a; Kılıç et al., 2018; Lawrence & Choe, 2021; Lin et al., 2020; Portugal et al., 2021). Nevertheless, there are limitations to the current literature on the topic. Some studies relied on parent-reported, often only mother-reported, screen time (Barr, 2010; Linebarger et al., 2014; Madigan et al., 2019) which could prone parents to select socially desirable answers and introduce a biased view of the actual time young children spend exposed to screen-based media. Furthermore, some studies assessed the same cognitive skills using different methods (Linebarger et al., 2014; Nathanson et al., 2014). While the methods chosen in these studies are still credible, they address different aspects of cognitive performance. For example, using performance-based measures to assess executive functions resemble children's optimal functioning, while ratings of everyday executive functions resemble children's typical functioning (Kostyrka-Allchorne et al., 2017; Toplak et al., 2013). It is, thus, advised for future studies to take into account the way different cognitive abilities are assessed while comparing research findings to previous studies, and avoid relaying only on a single measure to address complex cognitive skills. It is also necessary to include a methodology that will reduce the risks of inaccurate measurement of true screen time. For example, questionnaires filled out by parents should include precise division between various types of media, asking parents to report how much time their young children spend on each of them. There is also a great need of using more objective measures, such as screen time reports collected by smartphones and tablets. Additionally, as findings could be influenced by types of variables included in analyses, like family socio-economic status, parental well-being, or child daily activities, more research on the influence of screen exposure quantity including individual characteristics, screen content, and social and family context needs to be done.

In the reviewed literature we missed a greater number of studies that would include information about non-screen activities young children perform daily. Activities, such as spending time outdoors, physical activity, reading books, or doing puzzles support the development of visual-motor, attention, and strategic planning skills (Ponti et al., 2017; Radesky et al., 2015). Children who are exposed to screen-based media, but also engage in the above activities, could potentially be at lower risk of cognitive delays than children whose non-screen activities are limited. Moreover, it was shown that several sociodemographic characteristics play a role in exposure to screen-based media (Cingel & Krcmar, 2013; Ferjan Ramírez et al., 2021; Howe et al., 2017; Kühhirt & Klein, 2020; Levine et al., 2019; Masur et al., 2015; Matarma et al., 2016; Tombeau Cost et al., 2020; Trinh et al., 2020; Wiltshire et al., 2021). For example, pre-school children from high-demographic-risk families who experienced higher exposure to background television were at higher risk of executive function difficulties than children from low-demographic-risk families (Linebarger et al., 2014). Negative effects of screen exposure can also be no longer significant when controlling for demographic factors (Nayena Blankson et al., 2015). Thus, future studies should not only assess the type of media and amount of time children spend attending to screens, but they should also include and evaluate demographic correlates, cultural norms, family dynamics, and psychosocial risk factors. An interesting approach would be to study whether some screen-based devices, programs, and apps can be beneficial for children of specific backgrounds and act as supplements for children who are at risk for developmental delays. Here, the focus should be put especially on new types of screen-based media, like smartphones and tablets, as these are becoming more popular. Such an approach will help us to better understand the mechanisms through which exposure to screen-based media influences cognitive and socioemotional development in very young children and make research on screen-based media more ecologically valid.

Furthermore, the causal direction of the relationship between screen-based media and a child's cognitive and socioemotional development still needs to be established. As we have shown in this review, exposure to screen-based media can lead to poorer executive functions, attention difficulties, and behavioral problems. Nevertheless, it can also be true that children with developmental difficulties may show a preference for activities involving screen use and individual differences in cognitive abilities can moderate the influence of screen-based media use (Vedechkina & Borgonovi, 2021). Thus, there is a need for additional longitudinal research including individual differences to establish causality in the screen-based media and child's development relationship.

Finally, reviewed studies mainly assessed the impact of screen-based media within one of the developmental domains (e.g., cognitive), without describing the influence of reported effects on the other, e.g., socioemotional domain. Although cognitive development and socioemotional development are often regarded as separate systems in a child's development, both are linked in

reciprocal ways in the brain (Bell & Wolfe, 2004). Research has shown a number of important connections between brain activity, top- and bottom-down processing, and emotional development in children (Bell et al., 2010). Cognitive development helps young children develop socioemotional skills which then children need, to recognize emotions, improve their empathy skills or select appropriate behaviors. For example, the development of executive functions and attentional skills is not only relevant to planning and decision-making, but it also supports the development of emotion and behavior regulation (Diamond, 2013; Calkins & Marcovitch, 2010; Posner & Rothbart, 2006). Literature findings reported in this review show that, for example, earlier first-time exposure and background exposure can not only lead to weaker attentional skills and poorer executive functions (Pempek et al., 2014) but can also negatively impact socioemotional development and result in behavioral problems (Radesky et al., 2014). It will be, thus, crucial for future studies to integrate the concept of socioemotional and cognitive processes while assessing the impact of screen-based media in

Box 1
Recommendations regarding screen-based media use.

Screen-based media use by young children – recommendations

Parents:

- No screen time for children younger than 2 years, with an exception of video chatting
- Minimize screen time for children 2–5 (max 1 h), providing alternative activities
- Avoid exposing children to background screens, e.g., by turning TV off if no one is watching or when child is present in the room
- Engage in co-viewing and mediating strategies, by e.g., creating rules on screen-time and which content is allowed to be viewed, explaining what is happening on the screen, asking questions about viewed content
- Select interactive media content and use media together with your child
- Avoid fast-paced programs and apps with highly distracting content, select programs that are not interrupted with commercials
- Screen media should not be used as means to calm children, with an exception of special times, e.g., during medical procedures or flights
- Use of screen-devices should be avoided by all family members during meal and playtimes, right before nap/bedtime, and during family gatherings
- Discuss any concerns regarding child screen-media use with healthcare providers
- Create a personalized media plan using a Family Media Plan platform developed by AAP with the help of a healthcare provider if necessary

Medical professionals:

- Inform parents about the consequences of screen-use by young children and highlight the importance of face-to-face interactions
- Provide parents with a list of alternative activities they can do with their young children
- Encourage parents to select high quality content of screen media
- Together with families, develop personalized media plans that will meet each family needs
- If needed, use interventions addressing parental concerns, family status

Media industry:

- Develop apps and programs that are interactive, are adapted to the child's developmental stage, are comprehensible to young children, facilitate participation of caregivers
- Consult new videos, apps, programs (especially educational ones) with specialists in child development, to evaluate their suitability for young children
- Exclude advertisements in your products
- Include parental control and time-limit options in new developments

Policymakers:

- Collaborate with medical professionals, media industry, as well as families, to create policies that best address public interest and the safe development of young children exposed to screen media
- Monitor new developments of media industry to ensure to compliance with the recommendations, e.g., media content should be suitable for addressed age group and do not contain violence

early childhood.

To sum up, the main highlight emerges from the existing literature on screen-based media and early childhood development: different characteristics of screens and different types of screen use contribute to cognitive and socioemotional outcomes in different ways. Complex features of screen-based media should be carefully analyzed within different contexts, like screen exposure during family routines or other daily non-screen activities young children perform. Such studies can bring more clarity on which types and forms of screen-based media use are particularly harmful and which are beneficial during early childhood. Longitudinal studies with standardized and well-established methodology are also needed to judge which developmental outcomes from early screen-based media exposure during the first five years of life are most likely.

3.1. Prevention recommendations

Research outcomes and information currently available to parents, other caregivers, and medical professionals on the risks and benefits of screen media exposure in young children are mixed. On one hand, parents hear about the developmental and educational benefits of screen media, especially new apps. On the other hand, they hear children can develop a problematic relationship with screens and it might hamper their development. Thus, proper education of those involved in young children's life on how to create a screen media safe environment needs to be introduced. Often, parents are not aware of the actual impact of screen-based media on their children (Haines et al., 2013). Many parents seek clear and reliable information regarding proper screen-based media use by young children. Thus, recommendations for young children's screen media exposure should be frequently evaluated and adapted according to the rapidly changing digital environment. Furthermore, these recommendations should address family dynamics and concerns. To facilitate that, health practitioners, educators, and researchers should collaborate with families and focus on family needs.

Based on the research finding described in this review, we provide several recommendations for parents, medical professionals, policymakers, and the media industry which can be implemented to minimize the risks of screen exposure and its negative effects on young children. These recommendations are summarized in Box 1. Overall, medical professionals should educate young parents about the potential risks and benefits of screen exposure for children under the age of 5. Furthermore, they should provide parents with clear guidelines. Such guidelines can encourage parents to eliminate direct exposure to screen media of children under 2 years and control the amount of time older children spend in front of screens. Parents can also be provided with a list of alternative activities, such as spending time outdoors, interacting with peers and family members, or reading books, which have been shown to positively impact a child's cognitive and socioemotional development (Horowitz-Kraus & Hutton, 2018; Madigan et al., 2019; Zeng et al., 2017). If problems concerning screen use emerge, medical professionals can implement interventions suitable for a specific family situation.

To facilitate their children's development, parents should be aware of the content of television programs and apps their children focus on. It is recommended that parents watch a program themselves before allowing it for their children to see, and decide whether the content of videos or apps is following family values and has characteristics recommended by professionals. Despite the difficulties with content comprehension of educational media content, toddlers may still imitate behavior presented on screens. Thus, it is best to select programs with positive and pro-social content. Furthermore, parents are encouraged to mediate their children's screen-use by creating house rules on screen-time, allowed content, type of screen media, and when screen-viewing is not allowed (e.g., during meal times or right before bedtime). Screen-based media which are being used should be switched off, especially when a child is present in the same room, to reduce background exposure. Finally, parents should not use screen media to calm their children, except for special, highly stressful situations, such as medical procedures or during flights. When it comes to digital-media developers, especially those who develop content for very young children, they are highly advised to collaborate with child development specialists on designing videos and apps which will be evidence-based and are most suitable and appropriate for such a young audience. Based on the research findings, programs aimed at young children should be slow-paced, adapted to the child's cognitive abilities, and lack distractions, such as commercials. Screen-based media content should also be meaningful, engaging, and interactive, and encourage parent and child co-use (Hirsh-Pasek et al., 2015; Skaug et al., 2018). To support healthy screen-based media use, policymakers should collaborate with researchers and developmental professionals, the media industry, as well as families, to create policies that best address the interest of children and their healthy development. This review might be of initial help.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This work was supported by funding from the Ministry of the Interior and Kingdom Relations (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, BZK, the Netherlands, Project Number 2019-128527). The authors thank peer reviewers for their valuable feedback on the manuscript.

References

AAP, A.A. of P. (2016). *American Academy of Pediatrics Announces New Recommendations for Children's Media Use*. ⟨https://www.aap.org/en/news-room/news-releases/aap/2016/aap-announces-new-recommendations-for-media-use/⟩.

Ackerman, B. P., & Brown, E. D. (2010). Physical and psychosocial turmoil in the home and cognitive development. *Chaos and Its Influence on Children's Development: An Ecological Perspective*, 35–47. https://doi.org/10.1037/12057-003

Alade, F., Lauricella, A. R., Beaudoin-Ryan, L., & Wartella, E. (2016). Measuring with Murray: Touchscreen technology and preschoolers' STEM learning. *COMPUTERS IN HUMAN BEHAVIOR, 62*, 433–441. https://doi.org/10.1016/j.chb.2016.03.080

Alroqi, H., Serratrice, L., & Cameron-Faulkner, T. (2022). The association between screen media quantity, content, and context and language development. *Journal of Child Language*, 1–29. https://doi.org/10.1017/S0305000922000265

Anderson, D. R., & Hanson, K. G. (2010). From blooming, buzzing confusion to media literacy: The early development of television viewing. *DEVELOPMENTAL REVIEW, 30*(2, SI), 239–255. https://doi.org/10.1016/j.dr.2010.03.004

Anderson, D. R., Huston, A. C., Schmitt, K. L., Linebarger, D. L., & Wright, J. C. (2001). Early childhood television viewing and adolescent behavior: The recontact study. *Monogr Soc Res Child Dev* (Vol. 66,(Issue (1)), I–VIII.

Archer, K., Wood, E., & de Pasquale, D. (2021). Examining joint parent-child interactions involving infants and toddlers when introducing mobile technology. *Infant Behavior and Development, 63*, Article 101568. https://doi.org/10.1016/J.INFBEH.2021.101568

Arumugam, C. T., Said, M. A., & Nik Farid, N. D. (2021). Screen-based media and young children: Review and recommendations. *Malaysian Family Physician, 16*(2), 7–13. https://doi.org/10.51866/rv1143

Bandura, A. (1994). Social cognitive theory of mass communication. In J. Bryant, & D. Zillman (Eds.), *Media effects: Advances in theory and research* (pp. 61–90). Hillsdale, NJ: Erlbaum.

Barr, R. (2010). Transfer of learning between 2D and 3D sources during infancy: Informing theory and practice. *Developmental Review: DR, 30*(2), 128. https://doi.org/10.1016/J.DR.2010.03.001

Barr, R. (2013). Memory constraints on infant learning from picture books, television, and touchscreens. *Child Development Perspectives, 7*(4), 205–210. https://doi.org/10.1111/CDEP.12041

Barr, R. (2019). Growing up in the digital age: Early learning and family media ecology. *Current Directions in Psychological Science, 28*(4), 341–346. https://doi.org/10.1177/0963721419838245

Barr, R., Lauricella, A., Zack, E., & Calvert, S.L. (2010). Infant and Early Childhood Exposure to Adult-Directed and Child-Directed Television Programming: Relations with Cognitive Skills at Age Four (Vol. 56, Issue 1). https://www.jstor.org/stable/23098082.

Barrett, L.F., Mesquita, B., Ochsner, K.N., & Gross, J.J. (2006). The Experience of Emotion. Https://Doi-Org.Tilburguniversity.Idm.Oclc.Org/10.1146/Annurev.Psych.58.110405.085709, 58, 373–403. https://doi.org/10.1146/ANNUREV.PSYCH.58.110405.085709.

Beck, A. L., Takayama, J., Badiner, N., & Halpern-Felsher, B. (2015). Latino parents' beliefs about television viewing by infants and toddlers. *Journal of Health Care for the Poor and Underserved, 26*(2), 463–474. https://doi.org/10.1353/HPU.2015.0037

Bell, M. A., Greene, D. R., & Wolfe, C. D. (2010). Psychobiological mechanisms of cognition—emotion integration in early development. *Child development at the intersection of emotion and cognition* (pp. 115–132). American Psychological Association. https://doi.org/10.1037/12059-007

Bell, M. A., & Wolfe, C. D. (2004). Emotion and cognition: an intricately bound developmental process. *Child Development, 75*(2), 366–370. https://doi.org/10.1111/J.1467-8624.2004.00679.X

Bentley, G. F., Turner, K. M., & Jago, R. (2016). Mothers' views of their preschool child's screen-viewing behaviour: A qualitative study. *BMC Public Health, 16*(1). https://doi.org/10.1186/S12889-016-3440-Z

Bergmann, C., Dimitrova, N., Alaslani, K., Almohammadi, A., Alroqi, H., Aussems, S., Barokova, M., Davies, C., Gonzalez-Gomez, N., Gibson, S. P., Havron, N., Horowitz-Kraus, T., Kanero, J., Kartushina, N., Keller, C., Mayor, J., Mundry, R., Shinskey, J., & Mani, N. (2022). Young children's screen time during the first COVID-19 lockdown in 12 countries. *Scientific Reports 2022, 12*(1), 1–15. https://doi.org/10.1038/s41598-022-05840-5

Brown, A., & Smolenaers, E. (2018). Parents' interpretations of screen time recommendations for children younger than 2 years. *JOURNAL OF FAMILY ISSUES, 39*(2), 406–429. https://doi.org/10.1177/0192513X16646595

Brownell, C. A. (2013). Early development of prosocial behavior: Current perspectives. *Infancy: The Official Journal of the International Society on Infant Studies, 18*(1), 1. https://doi.org/10.1111/INFA.12004

Cacioppo, J.T., & Berntson, G.G. (2016). The Affect System: Architecture and Operating Characteristics. Https://Doi-Org.Tilburguniversity.Idm.Oclc.Org/10.1111/1467–8721.00031, 8(5), 133–137. https://doi.org/10.1111/1467–8721.00031.

Carson, V., Kuzik, N., Hunter, S., Wiebe, S. A., Spence, J. C., Friedman, A., Tremblay, M. S., Slater, L. G., & Hinkley, T. (2015). Systematic review of sedentary behavior and cognitive development in early childhood. *Preventive Medicine, 78*, 115–122. https://doi.org/10.1016/j.ypmed.2015.07.016

Cerniglia, L., & Cimino, S. (2020). A reflection on controversial literature on screen time and educational apps use in 0–5 years old children. *International Journal of Environmental Research and Public Health, 17*(13), 1–4. https://doi.org/10.3390/ijerph17134641

Chaudron, S., Gioia, R. di, & Gemo, M. (2018). Young Children (0–8) and Digital Technology, a Qualitative Study Across Europe.

Chen, W., & Adler, J. L. (2019). Assessment of screen exposure in young children, 1997 to 2014. *JAMA Pediatrics, 173*(4), 391–393. https://doi.org/10.1001/JAMAPEDIATRICS.2018.5546

Cheung, C. H. M. M., Bedford, R., Saez De Urabain, I. R., Karmiloff-Smith, A., Smith, T. J., de Urabain, I. R. S., Karmiloff-Smith, A., Smith, T. J., Saez De Urabain, I. R., Karmiloff-Smith, A., & Smith, T. J. (2017). Daily touchscreen use in infants and toddlers is associated with reduced sleep and delayed sleep onset. *Scientific Reports, 7*. https://doi.org/10.1038/srep46104

Chindamo, S., Buja, A., DeBattisti, E., Terraneo, A., Marini, E., Gomez Perez, L. J., Marconi, L., Baldo, V., Chiamenti, G., Doria, M., Ceschin, F., Malorgio, E., Tommasi, M., Sperotto, M., Buzzetti, R., & Gallimberti, L. (2019). Sleep and new media usage in toddlers. *European Journal of Pediatrics, 178*(4), 483–490. https://doi.org/10.1007/s00431-019-03318-7

Choi, K., & Kirkorian, H. L. (2016). Touch or watch to learn? Toddlers' object retrieval using contingent and noncontingent video. *Psychological Science, 27*(5), 726–736. https://doi.org/10.1177/0956797616636110

Chonchaiya, W., Sirachairat, C., Vijakkhana, N., Wilaisakditipakorn, T., & Pruksananonda, C. (2015). Elevated background TV exposure over time increases behavioural scores of 18-month-old toddlers. *Acta Paediatrica, 104*(10), 1039–1046. https://doi.org/10.1111/APA.13067

Cingel, D. P., & Krcmar, M. (2013). Predicting media use in very young children: The role of demographics and parent attitudes. *Communication Studies, 64*(4), 374–394. https://doi.org/10.1080/10510974.2013.770408

Cingel, D. P., & Krcmar, M. (2017). Prosocial television, preschool children's moral judgments, and moral reasoning: The role of social moral intuitions and perspective-taking. *Communication Research, 46*(3), 355–374. https://doi.org/10.1177/0093650217733846

Clark, L. S. (2011). Parental mediation theory for the digital age. *Communication Theory, 21*(4), 323–343. https://doi.org/10.1111/J.1468-2885.2011.01391.X

Cliff, D. P., Howard, S. J., Radesky, J. S., McNeill, J., & Vella, S. A. (2018). Early childhood media exposure and self-regulation: Bidirectional longitudinal associations. *Academic Pediatrics, 18*(7), 813–819. https://doi.org/10.1016/j.acap.2018.04.012

Cohen, R. A. (2014). Focused and sustained attention. *The Neuropsychology of Attention*, 89–112. https://doi.org/10.1007/978-0-387-72639-7_6

Common Sense Media. (2013). Zero to Eight: Children's Media Use in America.

Connell, S. L., Lauricella, A. R., & Wartella, E. (2015). Parental co-use of media technology with their young children in the USA. *Journal of Children and Media, 9*(1), 5–21. https://doi.org/10.1080/17482798.2015.997440

Conners-Burrow, N.A., Mckelvey, L.M., & Fussell, J.J. (2011). Social Outcomes Associated With Media Viewing Habits of Low-Income Preschool Children. Https://Doi.Org/10.1080/10409289.2011.550844, 22(2), 256–273. https://doi.org/10.1080/10409289.2011.550844.

Corkin, M. T., Henderson, A. M. E., Peterson, E. R., Kennedy- Costantini, S., Sharplin, H. S., & Morrison, S. (2021). Associations between technoference, quality of parent-infant interactions, and infants' vocabulary development. *Infant Behavior and Development, 64*, Article 101611. https://doi.org/10.1016/J.INFBEH.2021.101611

Courage, M. L. (2017). Screen media and the youngest viewers: Implications for attention and learning. *Cognitive Development in Digital Contexts*, 3–28. https://doi.org/10.1016/B978-0-12-809481-5.00001-8

Courage, M. L., & Setliff, A. E. (2010). When babies watch television: Attention-getting, attention-holding, and the implications for learning from video material. *In Developmental Review* (Vol. 30,(Issue 2), 220–238. https://doi.org/10.1016/j.dr.2010.03.003

Coyne, S. M., Radesky, J., Collier, K. M., Gentile, D. A., Linder, J. R., Nathanson, A. I., Rasmussen, E. E., Reich, S. M., & Rogers, J. (2017). Parenting and digital media. *In PEDIATRICS* (Vol. 140). ⟨www.aappublications.org/news⟩.

Cristia, A., & Seidl, A. (2015). Parental reports on touch screen use in early childhood. *PloS One, 10*(6). https://doi.org/10.1371/JOURNAL.PONE.0128338

Dayanim, S., & Namy, L. L. (2015). Infants learn baby signs from video. *Child Development, 86*(3), 800–811. https://doi.org/10.1111/cdev.12340

DeLoache, J. S., Chiong, C., Sherman, K., Islam, N., Vanderborght, M., Troseth, G. L., Strouse, G. A., & O'Doherty, K. (2010). Do babies learn from baby media? *Psychological Science, 21*(11), 1570–1574. https://doi.org/10.1177/0956797610384145

Desmarais, E., Brown, K., Campbell, K., French, B. F., Putnam, S. P., Casalin, S., Linhares, M. B. M., Lecannelier, F., Wang, Z., Raikkonen, K., Heinonen, K., Tuovinen, S., Montirosso, R., Provenzi, L., Park, S. Y., Han, S. Y., Lee, E. G., Huitron, B., de Weerth, C., & Gartstein, M. A. (2021). Links between television exposure and toddler dysregulation: Does culture matter? *Infant Behavior and Development, 63*, Article 101557. https://doi.org/10.1016/J.INFBEH.2021.101557

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64*, 135–168. https://doi.org/10.1146/ANNUREV-PSYCH-113011-143750

Elias, N., & Sulkin, I. (2019). Screen-assisted parenting: The relationship between toddlers' screen time and parents' use of media as a parenting tool. *Journal of Family Issues, 40*(18), 2801–2822. https://doi.org/10.1177/0192513X19864983

Ferjan Ramírez, N., Hippe, D. S., & Shapiro, N. (2021). Exposure to electronic media between 6 and 24 months of age: An exploratory study. *Infant Behavior and Development, 63*, Article 101549. https://doi.org/10.1016/J.INFBEH.2021.101549

Fidler, A. E., Zack, E., & Barr, R. (2010). Television viewing patterns in 6- to 18-month-olds: The role of caregiver–infant interactional quality. *Infancy, 15*(2), 176–196. https://doi.org/10.1111/J.1532-7078.2009.00013.X

Fisch, S. M. (2000). A capacity model of children's comprehension of educational content on television. *Media Psychology, 2*(1), 63–91. https://doi.org/10.1207/S1532785XMEP0201_4

Fitzpatrick, C., Barnett, T., & Pagani, L. S. (2012). Early exposure to media violence and later child adjustment. *Journal of Developmental and Behavioral Pediatrics: JDBP, 33*(4), 291–297. https://doi.org/10.1097/DBP.0B013E31824EAAB3

Fitzpatrick, C., Oghia, M. J., Melki, J., & Pagani, L. S. (2016). Early childhood exposure to media violence: What parents and policymakers ought to know. *South African Journal of Childhood Education, 6*(1), 6. https://doi.org/10.4102/SAJCE.V6I1.431

Flynn, R.M., Wong, K.M., Neuman, S.B., & Kaefer, T. (2019). Children's attention to screen-based pedagogical supports: an eye-tracking study with low-income preschool children in the United States. Https://Doi-Org.Tilburguniversity.Idm.Oclc.Org/10.1080/17482798.2019.1575887, 13(2), 180–200. https://doi.org/10.1080/17482798.2019.1575887.

Galetzka, C. (2017). Commentary: Mobile and interactive media use by young children: The good, the bad, and the unknown. In *In Frontiers in Psychology* (Vol. 8). Frontiers Research Foundation,. https://doi.org/10.3389/fpsyg.2017.00461

Geraci, A., & Surian, L. (2011). The developmental roots of fairness: infants' reactions to equal and unequal distributions of resources. *Developmental Science, 14*(5), 1012–1020. https://doi.org/10.1111/J.1467-7687.2011.01048.X

Golden, S. L., Blake, J. W. C. C., & Giuliano, K. K. (2020). Parental decision-making: infant engagement with smartphones. *Infant Behavior \& Development, 61*, Article 101497. https://doi.org/10.1016/j.infbeh.2020.101497

Gordon-Hacker, A., & Gueron-Sela, N. (2020). Maternal use of media to regulate child distress: A double-edged sword? Longitudinal links to toddlers' negative emotionality. *Cyberpsychology Behavior and Social Networking, 23*(6), 400–405. https://doi.org/10.1089/cyber.2019.0487

Gueron-Sela, N., & Gordon-Hacker, A. (2020). Longitudinal links between media use and focused attention through toddlerhood: A cumulative risk approach. *Frontiers in Psychology, 11*. https://doi.org/10.3389/fpsyg.2020.569222

Haines, J., O'Brien, A., McDonald, J., Goldman, R. E., Evans-Schmidt, M., Price, S., King, S., Sherry, B., & Taveras, E. M. (2013). Television viewing and televisions in bedrooms: Perceptions of racial/ethnic minority parents of young children. *Journal of Child and Family Studies, 22*(6), 749–756. https://doi.org/10.1007/S10826-012-9629-6/TABLES/3

Hanson, K. G., Lavigne, H. J., Gover, S. G., & Anderson, D. R. (2021). Parent language with toddlers during shared storybook reading compared to coviewing television. *Infant Behavior and Development, 65*, Article 101646. https://doi.org/10.1016/J.INFBEH.2021.101646

Hawi, N. S., & Rupert, M. S. (2015). Impact of e-discipline on children's screen time. *Https://Home-Liebertpub-Com Tilburguniversity Idm Oclc Org/Cyber, 18*(6), 337–342. https://doi.org/10.1089/CYBER.2014.0608

Hendry, A., Jones, E. J. H., & Charman, T. (2016). Executive function in the first three years of life: Precursors, predictors and patterns. *Developmental Review, 42*, 1–33. https://doi.org/10.1016/J.DR.2016.06.005

Hirsh-Pasek, K., Zosh, J. M., Golinkoff, R. M., Gray, J. H., Robb, M. B., & Kaufman, J. (2015). Putting education in "educational". *Apps: Lessons From the Science of Learning, 16*(1), 3–34. https://doi.org/10.1177/1529100615569721

Horowitz-Kraus, T., & Hutton, J. S. (2018). Brain connectivity in children is increased by the time they spend reading books and decreased by the length of exposure to screen-based media. *Acta Paediatrica, International Journal of Paediatrics, 107*(4), 685–693. https://doi.org/10.1111/apa.14176

Howe, A. S., Heath, A. L. M., Lawrence, J., Galland, B. C., Gray, A. R., Taylor, B. J., Sayers, R., & Taylor, R. W. (2017). Parenting style and family type, but not child temperament, are associated with television viewing time in children at two years of age. *PLOS ONE, 12*(12), Article e0188558. https://doi.org/10.1371/JOURNAL.PONE.0188558

Huber, B., Tarasuik, J., Antoniou, M. N., Garrett, C., Bowe, S. J., & Kaufman, J. (2016). Young children's transfer of learning from a touchscreen device. *Computers in Human Behavior, 56*, 56–64. https://doi.org/10.1016/J.CHB.2015.11.010

Huber, B., Yeates, M., Meyer, D., Fleckhammer, L., & Kaufman, J. (2018). The effects of screen media content on young children's executive functioning. *Journal of Experimental Child Psychology, 170*, 72–85. https://doi.org/10.1016/J.JECP.2018.01.006

Hughes, C., & Devine, R. T. (2019). For better or for worse? Positive and negative parental influences on Young Children's executive function. *Child Development, 90*(2), 593–609. https://doi.org/10.1111/CDEV.12915

Jackson, D. B. (2018). Does TV viewing during toddlerhood predict social difficulties and conduct problems? *Infant and Child Development, 27*(4). https://doi.org/10.1002/icd.2086

Jean Piaget. (1965). *The Child's Conception of Number*. W. W. Norton & Co.

Jing, M., & Kirkorian, H. L. (2020). Teaching with televised stories: A story-focused narrative preview supports learning in young children. *Child Development, 91*(5), e1101–e1118. https://doi.org/10.1111/CDEV.13385

Jusienė, R., Rakickienė, L., Breidokienė, R., & Laurinaitytė, I. (2020). Executive function and screen-based media use in preschool children. *Infant and Child Development, 29*(1). https://doi.org/10.1002/icd.2173

Kabali, H. K., Irigoyen, M. M., Nunez-Davis, R., Budacki, J. G., Mohanty, S. H., Leister, K. P., & Bonner, R. L. (2015). Exposure and use of mobile media devices by young children. *Pediatrics, 136*(6), 1044–1050. https://doi.org/10.1542/peds.2015-2151

Kaur, N., Gupta, M., Malhi, P., & Grover, S. (2019). Screen time in under-five children. *Indian Pediatrics, 56*(9), 773–788.

Kerai, S., Almas, A., Guhn, M., Forer, B., & Oberle, E. (2022). Screen time and developmental health: Results from an early childhood study in Canada. *BMC Public Health, 22*(1), 1–9. https://doi.org/10.1186/S12889-022-12701-3/TABLES/3

Kildare, C. A., & Middlemiss, W. (2017). Impact of parents mobile device use on parent-child interaction: A literature review. *Computers in Human Behavior, 75*, 579–593. https://doi.org/10.1016/J.CHB.2017.06.003

Kılıç, A. O., Sari, E., Yucel, H., Oğuz, M. M., Polat, E., Acoglu, E. A., & Senel, S. (2018). Exposure to and use of mobile devices in children aged 1–60 months. *European Journal of Pediatrics*. https://doi.org/10.1007/s00431-018-3284-x

Kirkorian, H., Choi, K., & Pempek, T. (2016). Toddlers' word learning from contingent and noncontingent video on touch screens. *Child Development, 87*(2), 405–413. https://doi.org/10.1111/CDEV.12508

Kirkorian, H. L. (2018). When and how do interactive digital media help children connect what they see on and off the screen? *Child Development Perspectives, 12*(3), 210–214. https://doi.org/10.1111/cdep.12290

Kirkorian, H. L., Anderson, D. R., & Keen, R. (2012). Age differences in online processing of video: An eye movement study. *Child Development, 83*(2), 497–507. https://doi.org/10.1111/J.1467-8624.2011.01719.X

Kolb, B., & Gibb, R. (2011). Brain plasticity and behaviour in the developing brain. *Journal of the Canadian Academy of Child and Adolescent Psychiatry, 20*(4), 265.

Kostyrka-Allchorne, K., Cooper, N. R., & Simpson, A. (2017). The relationship between television exposure and children's cognition and behaviour: A systematic review. *Developmental Review, 44*, 19–58. https://doi.org/10.1016/J.DR.2016.12.002

Krcmar, M. (2010). Can social meaningfulness and repeat exposure help infants and toddlers overcome the video deficit. *Media Psychology, 13*(1), 31–53. https://doi.org/10.1080/15213260903562917

Krcmar, M. (2014). Can Infants and Toddlers Learn Words from Repeat Exposure to an Infant Directed DVD? Http://Dx.Doi.Org.Tilburguniversity.Idm.Oclc.Org/10.1080/08838151.2014.906429, 58(2), 196–214. https://doi.org/10.1080/08838151.2014.906429.

Krogh, M. T., Egmose, I., Stuart, A. C., Madsen, E. B., Haase, T. W., & Væver, M. S. (2021). A longitudinal examination of daily amounts of screen time and technoference in infants aged 2–11 months and associations with maternal sociodemographic factors. *Infant Behavior and Development, 63*, Article 101543. https://doi.org/10.1016/J.INFBEH.2021.101543

Kucker, S. C. (2021). Processes and pathways in development via digital media: Examples from word learning. *Infant Behavior and Development*, *63*. https://doi.org/10.1016/j.infbeh.2021.101559

Kühhirt, M., & Klein, M. (2020). Parental education, television exposure, and children's early cognitive, language and behavioral development. *Social Science Research, 86*, Article 102391. https://doi.org/10.1016/J.SSRESEARCH.2019.102391

Lapierre, M., Piotrowski, J., & Linebarger, D. (2012). Background television in the homes of US children. *Pediatrics, 130*(5), 839–846. https://doi.org/10.1542/PEDS.2011-2581

Lauricella, A. R., Barr, R., & Calvert, S. L. (2016). Toddler learning from video: Effect of matched pedagogical cues. *INFANT BEHAVIOR \& DEVELOPMENT, 45*(A), 22–30. https://doi.org/10.1016/j.infbeh.2016.08.001

Lauricella, A. R., Gola, A. A. H., & Calvert, S. L. (2011). Toddlers' learning from socially meaningful video characters. *Media Psychology, 14*(2), 216–232. https://doi.org/10.1080/15213269.2011.573465

Lauricella, A. R., Wartella, E., & Rideout, V. J. (2015). Young children's screen time: The complex role of parent and child factors. *Journal of Applied Developmental Psychology, 36*, 11–17. https://doi.org/10.1016/J.APPDEV.2014.12.001

Lawrence, A., & Choe, D. E. (2021). Mobile media and young children's cognitive skills: A review. In *In Academic Pediatrics* (Vol. 21, pp. 996–1000). Elsevier Inc,. https://doi.org/10.1016/j.acap.2021.01.007

Lederer, Y., Artzi, H., & Borodkin, K. (2021). The effects of maternal smartphone use on mother–child interaction. *Child Development*. https://doi.org/10.1111/CDEV.13715

Lerner, C., & Barr, R. (2015). Screen sense: Setting the record straight–research-based guidelines for screen use for children under 3 years old. *Zero to Three, 35*(4), 1–10.

Levine, L. E., Waite, B. M., Bowman, L. L., & Kachinsky, K. (2019). Mobile media use by infants and toddlers. *Computers in Human Behavior, 94*, 92–99. https://doi.org/10.1016/J.CHB.2018.12.045

Li, C., Mendoza, M., & Milanaik, R. (2018). Touchscreen device usage in infants and toddlers and its correlations with cognitive development. *Pediatrics & Health Research, 2*(1). https://doi.org/10.21767/2574-2817.100013

Lillard, A. S., Drell, M. B., Richey, E. M., Boguszewski, K., & Smith, E. D. (2015). Further examination of the immediate impact of television on children's executive function. *Developmental Psychology, 51*(6), 792–805. https://doi.org/10.1037/A0039097

Lillard, A. S., Li, H., & Boguszewski, K. (2015). Television and children's executive function. In *Advances in Child Development and Behavior* (Vol. 48, pp. 219–248). Academic Press Inc,. https://doi.org/10.1016/bs.acdb.2014.11.006

Lillard, A. S., & Peterson, J. (2011). The immediate impact of different types of television on Young children's executive function. *Pediatrics, 128*(4), 644–649. https://doi.org/10.1542/PEDS.2010-1919

Lin, H. P., Chen, K. L., Chou, W., Yuan, K. S., Yen, S. Y., Chen, Y. S., & Chow, J. C. (2020). Prolonged touch screen device usage is associated with emotional and behavioral problems, but not language delay, in toddlers. *Infant Behavior and Development*, *58*. https://doi.org/10.1016/j.infbeh.2020.101424

Lin, L. Y., Cherng, R. J., Chen, Y. J., Chen, Y. J., & Yang, H. M. (2015). Effects of television exposure on developmental skills among young children. *Infant Behavior and Development, 38*, 20–26. https://doi.org/10.1016/j.infbeh.2014.12.005

Linder, L. K., McDaniel, B. T., Stockdale, L., & Coyne, S. M. (2021). The impact of parent and child media use on early parent–infant attachment. *Infancy, 26*(4), 551–569. https://doi.org/10.1111/infa.12400

Linebarger, D.L., Barr, R., Lapierre, M.A., & Piotrowski, J.T. (2014). Associations Between Parenting, Media Use, Cumulative Risk, and Children's Executive Functioning. https://journals.lww.com/jrnldbp.

Livingstone, S., & Pothong, K. (2022). Imaginative play in digital environments: designing social and creative opportunities for identity formation. Https://Doi-Org.Tilburguniversity.Idm.Oclc.Org/10.1080/1369118X.2022.2046128, 25(4), 485–501. https://doi.org/10.1080/1369118X.2022.2046128.

Lovato, S. B., & Waxman, S. R. (2016a). Young children learning from touch screens: Taking a wider view. *Frontiers in Psychology, 7*. https://doi.org/10.3389/fpsyg.2016.01078

Lovato, S. B., & Waxman, S. R. (2016b). Young children learning from touch screens: Taking a wider view. *Frontiers in Psychology, 7*(JUL). https://doi.org/10.3389/FPSYG.2016.01078

Lytle, S. R., Garcia-Sierra, A., & Kuhl, P. K. (2018). Two are better than one: Infant language learning from video improves in the presence of peers. *Proceedings of the National Academy of Sciences, 115*(40), 9859–9866. https://doi.org/10.1073/PNAS.1611621115

Madigan, S., Browne, D., Racine, N., Mori, C., & Tough, S. (2019). Association between screen time and children's performance on a developmental screening test. *JAMA Pediatrics, 173*(3), 244–250. https://doi.org/10.1001/JAMAPEDIATRICS.2018.5056

Madigan, S., Racine, N., & Tough, S. (2020). Prevalence of preschoolers meeting vs exceeding screen time guidelines. *JAMA Pediatrics, 174*(1), 93–95. https://doi.org/10.1001/JAMAPEDIATRICS.2019.4495

Mares, M. L., Bonus, J. A., & Peebles, A. (2022). Love or comprehension? Exploring strategies for children's prosocial media effects. *Communication Research, 49*(6), 763–791. https://doi.org/10.1177/0093650218797411/ASSET/IMAGES/LARGE/10.1177_0093650218797411-FIG1.JPEG

Mares, M.-L., & Stephenson, L. J. (2017). Prosocial media use and effects. *The International Encyclopedia of Media Effects*, 1–13. https://doi.org/10.1002/9781118783764.WBIEME0153

Masur, E.F., Flynn, V., & Olson, J. (2015). The Presence of Background Television During Young Children's Play in American Homes. Http://Dx.Doi.Org.Tilburguniversity.Idm.Oclc.Org/10.1080/17482798.2015.1056818, 9(3), 349–367. https://doi.org/10.1080/17482798.2015.1056818.

Masur, E.F., Flynn, V., & Olson, J. (2016). Infants' background television exposure during play: Negative relations to the quantity and quality of mothers' speech and infants' vocabulary acquisition: First Language, 36(2), 109–123. https://doi.org/10.1177/0142723716639499.

Matarma, T., Koski, P., Löyttyniemi, E., & Lagström, H. (2016). The factors associated with toddlers' screen time change in the STEPS Study: A two-year follow-up. *Preventive Medicine, 84*, 27–33. https://doi.org/10.1016/J.YPMED.2015.12.014

McClure, E. R., Chentsova-Dutton, Y. E., Barr, R. F., Holochwost, S. J., & Parrott, W. G. (2015). "Facetime doesn't count": Video chat as an exception to media restrictions for infants and toddlers. *International Journal of Child-Computer Interaction, 6*, 1–6. https://doi.org/10.1016/j.ijcci.2016.02.002

McDaniel, B., & Radesky, J. (2018a). Technoference: Parent distraction with technology and associations with child behavior problems. *Child Dev, 89*(1), 100–109. https://doi.org/10.1111/cdev.12822
McDaniel, B. T., & Coyne, S. M. (2016). "Technoference": The interference of technology in couple relationships and implications for women's personal and relational well-being. *Psychology of Popular Media Culture, 5*(1), 85–98. https://doi.org/10.1037/PPM0000065
McDaniel, B. T., & Radesky, J. S. (2018b). Technoference: longitudinal associations between parent technology use, parenting stress, and child behavior problems. *Pediatric Research, 84*(2), 210–218. https://doi.org/10.1038/s41390-018-0052-6
McDaniel, B. T., & Radesky, J. S. (2020). Longitudinal associations between early childhood externalizing behavior, parenting stress, and child media use. *Cyberpsychology, Behavior, and Social Networking, 23*(6), 384–391. https://doi.org/10.1089/cyber.2019.0478
McHarg, G., Ribner, A. D., Devine, R. T., Hughes, C., Blair, C., Hughes, C., Mesman, J., Devine, R. T., Alink, L., Browne, W., Branger, M., Emmen, R., Foley, S., Kyriakou, L., Lindberg, A., McHarg, G., Ribner, A. D., Woudstra, M.-L., & Team, N. S. (2020). Infant screen exposure links to toddlers' inhibition, but not other EF constructs: A propensity score study. *INFANCY, 25*(2), 205–222. https://doi.org/10.1111/infa.12325
McNeill, J., Howard, S. J., Vella, S. A., & Cliff, D. P. (2021). Cross-sectional associations of application use and media program viewing with cognitive and psychosocial development in preschoolers. *International Journal of Environmental Research and Public Health, 18*(4), 1–14. https://doi.org/10.3390/ijerph18041608
Mendelsohn, A. L., Brockmeyer, C. A., Dreyer, B. P., Fierman, A. H., Berkule-Silberman, S. B., & Tomopoulos, S. (2010). Do verbal interactions with infants during electronic media exposure mitigate adverse impacts on their language development as toddlers. *Infant and Child Development, 19*(6), 577–593. https://doi.org/10.1002/ICD.711
Moser, A., Zimmermann, L., Dickerson, K., Grenell, A., Barr, R., & Gerhardstein, P. (2015). They can interact, but can they learn? Toddlers' transfer learning from touchscreens and television. *JOURNAL OF EXPERIMENTAL CHILD PSYCHOLOGY, 137*, 137–155. https://doi.org/10.1016/j.jecp.2015.04.002
Myers, L. J., Crawford, E., Murphy, C., Aka-Ezoua, E., & Felix, C. (2018). Eyes in the room trump eyes on the screen: effects of a responsive co-viewer on toddlers' responses to and learning from video chat. *JOURNAL OF CHILDREN AND MEDIA, 12*(3), 275–294. https://doi.org/10.1080/17482798.2018.1425889
Myers, L. J., Keyser, H., & Cors, M. (2019). Co-viewers support participation in video chat interactions, but live experiences promote richer word learning for 24- to 36-month-olds in the USA. *JOURNAL OF CHILDREN AND MEDIA, 13*(4), 415–432. https://doi.org/10.1080/17482798.2019.1646294
Myers, L. J., LeWitt, R. B., Gallo, R. E., & Maselli, N. M. (2017). Baby FaceTime: can toddlers learn from online video chat? *DEVELOPMENTAL SCIENCE, 20*(4). https://doi.org/10.1111/desc.12430
Nathanson, A. I., Aladé, F., Sharp, M. L., Rasmussen, E. E., & Christy, K. (2014). The relation between television exposure and executive function among preschoolers. *Developmental Psychology, 50*(5), 1497–1506. https://doi.org/10.1037/A0035714
Nathanson, A. I., & Rasmussen, E. E. (2011). TV viewing compared to book reading and toy playing reduces responsive maternal communication with toddlers and preschoolers. *Human Communication Research, 37*(4), 465–487. https://doi.org/10.1111/J.1468-2958.2011.01413.X
Nayena Blankson, A., O'Brien, M., Leerkes, E. M., Calkins, S. D., & Marcovitch, S. (2015). Do hours spent viewing television at ages 3 and 4 predict vocabulary and executive functioning at age 5? *Merrill-Palmer Quarterly, 61*(2), 264–289. https://doi.org/10.13110/MERRPALMQUAR1982.61.2.0264
Neuman, S. B., Wong, K. M., Flynn, R., & Kaefer, T. (2019). Learning vocabulary from educational media: The role of pedagogical supports for low-income preschoolers. *Journal of Educational Psychology, 111*(1), 32–44. https://doi.org/10.1037/EDU0000278
Nevski, E., & Siibak, A. (2016). The role of parents and parental mediation on 0-3-year olds' digital play with smart devices: Estonian parents' attitudes and practices. *Early Years, 36*(3, SI), 227–241. https://doi.org/10.1080/09575146.2016.1161601
Niiranen, J., Kiviruusu, O., Vornanen, R., Saarenpää-Heikkilä, O., & Juulia Paavonen, E. (2021). High-dose electronic media use in five-year-olds and its association with their psychosocial symptoms: A cohort study. *BMJ Open, 11*(3), 1–9. https://doi.org/10.1136/bmjopen-2020-040848
Nikkelen, S. W. C., Valkenburg, P. M., Huizinga, M., & Bushman, B. J. (2014). Media use and ADHD-related behaviors in children and adolescents: A meta-analysis. *Developmental Psychology, 50*(9), 2228–2241. https://doi.org/10.1037/a0037318
Nikken, P., & Opree, S. J. (2018). Guiding Young Children's digital media use: SES-differences in mediation concerns and competence. *Journal of Child and Family Studies, 27*(6), 1844–1857. https://doi.org/10.1007/s10826-018-1018-3
Nikken, P., & Schols, M. (2015). How and why parents guide the media use of young children. *Journal of Child and Family Studies, 24*(11), 3423–3435. https://doi.org/10.1007/S10826-015-0144-4/FIGURES/1
O'Toole, K. J., & Kannass, K. N. (2021). Background television and distractibility in young children: Does program content matter? *Journal of Applied Developmental Psychology*, *75*. https://doi.org/10.1016/j.appdev.2021.101280
Oflu, A., Tezol, O., Yalcin, S., Yildiz, D., Caylan, N., Ozdemir, D. F., Cicek, S., & Nergiz, M. E. (2021). Excessive screen time is associated with emotional lability in preschool children. *Archivos Argentinos Dèlelőtt Pediatria, 119*(2), 106–113. https://doi.org/10.5546/AAP.2021.106
Ostrov, J. M., Gentile, D. A., & Mullins, A. D. (2013). Evaluating the effect of educational media exposure on aggression in early childhood. *Journal of Applied Developmental Psychology, 34*(1), 38–44. https://doi.org/10.1016/J.APPDEV.2012.09.005
Peebles, A. (2020). Effects of media use on altruism in childhood and adolescence. *The International Encyclopedia of Media Psychology*, 1–9. https://doi.org/10.1002/9781119011071.IEMP0112
Peebles, A., Bonus, J. A., & Mares, M. L. (2018). Questions + answers + agency: Interactive touchscreens and Children's learning from a socio-emotional TV story. *Computers in Human Behavior, 85*, 339–348. https://doi.org/10.1016/J.CHB.2018.03.039
Pempek, T. A., Demers, L. B., Hanson, K. G., Kirkorian, H. L., & Anderson, D. R. (2011). The impact of infant-directed videos on parent–child interaction. *Journal of Applied Developmental Psychology, 32*(1), 10–19. https://doi.org/10.1016/J.APPDEV.2010.10.001
Pempek, T. A., Kirkorian, H. L., & Anderson, D. R. (2014). The effects of background television on the quantity and quality of child-directed speech by parents. *Journal of Children and Media, 8*(3), 211–222. https://doi.org/10.1080/17482798.2014.920715
Pempek, T. A., Kirkorian, H. L., Richards, J. E., Anderson, D. R., Lund, A. F., & Stevens, M. (2010). Video comprehensibility and attention in very young children. *Developmental Psychology, 46*(5), 1283–1293. https://doi.org/10.1037/A0020614
Ponti, M., Bélanger, S., Grimes, R., Heard, J., Johnson, M., Moreau, E., Norris, M., Shaw, A., Stanwick, R., van Lankveld, J., & Williams, R. (2017). Screen time and young children: Promoting health and development in a digital world. *Paediatrics & Child Health, 22*(8), 461–468. https://doi.org/10.1093/PCH/PXX123
Portugal, A. M., Bedford, R., Cheung, C. H. M., Mason, L., & Smith, T. J. (2021). Longitudinal touchscreen use across early development is associated with faster exogenous and reduced endogenous attention control. *Scientific Reports, 11*(1). https://doi.org/10.1038/s41598-021-81775-7
Poulain, T., Vogel, M., Neef, M., Abicht, F., Hilbert, A., Genuneit, J., Körner, A., & Kiess, W. (2018). Reciprocal associations between electronic media use and behavioral difficulties in preschoolers. *International Journal of Environmental Research and Public Health, 15*(4). https://doi.org/10.3390/ijerph15040814
Przybylski, A. K., & Weinstein, N. (2019). Digital screen time limits and young children's psychological well-being: Evidence from a population-based study. *Child Dev, 90*(1), e56–e65. https://doi.org/10.1111/cdev.13007
Radesky, J., Christakis, D., Hill, D., Ameenuddin, N., Chassiakos, Y., (Linda), R., Cross, C., Radesky, J., Hutchinson, J., Boyd, R., Mendelson, R., Moreno, M. A., Smith, J., Swanson, W. S., & Media, C. C. (2016a). Media and young minds. *Pediatrics, 138*(5). https://doi.org/10.1542/peds.2016-2591
Radesky, J., Miller, A. L., Rosenblum, K. L., Appugliese, D., Kaciroti, N., & Lumeng, J. C. (2015a). Maternal mobile device use during a structured parent-child interaction task. *Academic Pediatrics, 15*(2), 238–244. https://doi.org/10.1016/J.ACAP.2014.10.001
Radesky, J. S., & Christakis, D. A. (2016b). Increased screen time: Implications for early childhood development and behavior. In *Pediatric Clinics of North America* (Vol. 63, pp. 827–839). W.B. Saunders. https://doi.org/10.1016/j.pcl.2016.06.006
Radesky, J. S., Peacock-Chambers, E., Zuckerman, B., & Silverstein, M. (2016c). Use of mobile technology to calm upset children: Associations with social-emotional development. *JAMA Pediatrics, 170*(4), 397–399. https://doi.org/10.1001/JAMAPEDIATRICS.2015.4260
Radesky, J. S., Schumacher, J., & Zuckerman, B. (2015b). Mobile and interactive media use by young children: The good, the bad, and the unknown. *Pediatrics, 135*(1), 1–3. https://doi.org/10.1542/peds.2014-2251
Radesky, J. S., Silverstein, M., Zuckerman, B., & Christakis, D. A. (2014). Infant self-regulation and early childhood media exposure. *Pediatrics, 133*(5), E1172–E1178. https://doi.org/10.1542/peds.2013-2367

Raman, S., Guerrero-Duby, S., McCullough, J. L., Brown, M., Ostrowski-Delahanty, S., Langkamp, D., & Duby, J. C. (2017). Screen exposure during daily routines and a young child's risk for having social-emotional delay. *Clinical Pediatrics, 56*(13), 1244–1253. https://doi.org/10.1177/0009922816684600
Rasmussen, E. E., Shafer, A., Colwell, M. J., White, S., Punyanunt-Carter, N., Densley, R. L., & Wright, H. (2016). Relation between active mediation, exposure to Daniel Tiger's Neighborhood, and US preschoolers' social and emotional development. *Journal of Children and Media, 10*(4), 443–461. https://doi.org/10.1080/17482798.2016.1203806
Richert, R. A., Robb, M. B., Fender, J. G., & Wartella, E. (2010). Word learning from baby videos. *Archives of Pediatrics & Adolescent Medicine, 164*(5), 432–437. https://doi.org/10.1001/ARCHPEDIATRICS.2010.24
Rocha, B., & Nunes, C. (2020). Benefits and damages of the use of touchscreen devices for the development and behavior of children under 5 years old—a systematic review. *Psicologia: Reflexão e Crítica, 33*(1). https://doi.org/10.1186/S41155-020-00163-8
Roseberry, S., Hirsh-Pasek, K., & Golinkoff, R. M. (2014a). Skype me! Socially contingent interactions help toddlers learn language. *Child Development, 85*(3), 956. https://doi.org/10.1111/CDEV.12166
Roseberry, S., Hirsh-Pasek, K., & Golinkoff, R. M. (2014b). Skype Me! Socially contingent interactions help toddlers learn language. *Child Development, 85*(3), 956–970. https://doi.org/10.1111/CDEV.12166
Rothbart, M. K., Sheese, B. E., Rueda, M. R., & Posner, M. I. (2011). Developing mechanisms of self-regulation in early life. *Emotion Review, 3*(2), 207. https://doi.org/10.1177/1754073910387943
Russo-Johnson, C., Troseth, G., Duncan, C., & Meseghina, A. (2017). All tapped out: Touchscreen interactivity and young children's word learning. *Frontiers in Psychology, 8*(APR). https://doi.org/10.3389/FPSYG.2017.00578
Sameroff, A. (2010). A unified theory of development: a dialectic integration of nature and nurture. *Child Development, 81*(1), 6–22. https://doi.org/10.1111/J.1467-8624.2009.01378.X
Scarf, D., & Hinten, A. E. (2018). Television format and children's executive function. *Pediatrics, 141*(3). https://doi.org/10.1542/PEDS.2017-2674
Setliff, A. E., & Courage, M. L. (2011). Background television and infants' allocation of their attention during toy play. *Infancy, 16*(6), 611–639. https://doi.org/10.1111/j.1532-7078.2011.00070.x
Sheehan, K. J., & Uttal, D. H. (2016a). Children's learning from touch screens: A dual representation perspective. *Frontiers in Psychology, 7*(AUG), 1220. https://doi.org/10.3389/FPSYG.2016.01220/BIBTEX
Sheehan, K. J., & Uttal, D. H. (2016b). Children's learning from touch screens: A dual representation perspective. *Frontiers in Psychology, 7*(AUG), 1220. https://doi.org/10.3389/FPSYG.2016.01220/BIBTEX
Shin, E., Choi, K., Resor, J., & Smith, C. L. (2021). Why do parents use screen media with toddlers? The role of child temperament and parenting stress in early screen use. *Infant Behavior and Development, 64*, Article 101595. https://doi.org/10.1016/J.INFBEH.2021.101595
Skaug, S., Englund, K. T., Saksvik-Lehouillier, I., Lydersen, S., & Wichstrøm, L. (2018). Parent–child interactions during traditional and interactive media settings: A pilot randomized control study. *Scandinavian Journal of Psychology, 59*(2), 135–145. https://doi.org/10.1111/sjop.12420
Smith, H. (2020). Children, Executive Functioning, and Digital Media: A Review, 2020. Common Sense Media.
Sommer, K., Redshaw, J., Slaughter, V., Wiles, J., & Nielsen, M. (2021). The early ontogeny of infants' imitation of on screen humans and robots. *Infant Behavior and Development, 64*, Article 101614. https://doi.org/10.1016/J.INFBEH.2021.101614
Spinrad, T. L., Eisenberg, N., Gaertner, B., Popp, T., Smith, C. L., Kupfer, A., Greving, K., Liew, J., & Hofer, C. (2007). Relations of maternal socialization and toddlers' effortful control to children's adjustment and social competence. *Developmental Psychology, 43*(5), 1170–1186. https://doi.org/10.1037/0012-1649.43.5.1170
Strasburger, V. (2015). Should babies be watching and using screens? The answer is surprisingly complicated. *Acta Paediatrica, 104*(10), 967–968. https://doi.org/10.1111/APA.13105
Strouse, G. A., & Ganea, P. A. (2021). Learning to learn from video? 30-month-olds benefit from continued use of supportive scaffolding. *Infant Behavior and Development, 64*, Article 101574. https://doi.org/10.1016/J.INFBEH.2021.101574
Strouse, G. A., & Troseth, G. L. (2014). Supporting toddlers' transfer of word learning from video. *Cognitive Development, 30*(1), 47–64. https://doi.org/10.1016/J.COGDEV.2014.01.002
Strouse, G. A., Troseth, G. L., O'Doherty, K. D., & Saylor, M. M. (2018). Co-viewing supports toddlers' word learning from contingent and noncontingent video. *Journal of Experimental Child Psychology, 166*, 310–326. https://doi.org/10.1016/J.JECP.2017.09.005
Suggate, S. P., & Martzog, P. (2020). Screen-time influences children's mental imagery performance. *Developmental Science, 23*(6), 1–13. https://doi.org/10.1111/desc.12978
Supanitayanon, S., Trairatvorakul, P., & Chonchaiya, W. (2020). Screen media exposure in the first 2 years of life and preschool cognitive development: a longitudinal study. *Pediatric Research 2020 88:6, 88(6), 894–902*. https://doi.org/10.1038/s41390-020-0831-8
Tamana, S. K., Ezeugwu, V., Chikuma, J., Lefebvre, D. L., Azad, M. B., Moraes, T. J., Subbarao, P., Becker, A. B., Turvey, S. E., Sears, M. R., Dick, B. D., Carson, V., Rasmussen, C., Pei, J., & Mandhane, P. J. (2019). Screen-time is associated with inattention problems in preschoolers: Results from the CHILD birth cohort study. *PLoS ONE, 14*(4). https://doi.org/10.1371/JOURNAL.PONE.0213995
Tombeau Cost, K., Korczak, D., Charach, A., Birken, C., Maguire, J. L., Parkin, P. C., & Szatmari, P. (2020). Association of parental and contextual stressors with child screen exposure and child screen exposure combined with feeding. *JAMA Network Open, 3*(2). https://doi.org/10.1001/JAMANETWORKOPEN.2019.20557
Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry, 54*(2), 131–143. https://doi.org/10.1111/JCPP.12001
Trinh, M. H., Sundaram, R., Robinson, S. L., Lin, T. C., Bell, E. M., Ghassabian, A., & Yeung, E. H. (2020). Association of trajectory and covariates of children's screen media time. *JAMA Pediatrics, 174*(1), 71–78. https://doi.org/10.1001/JAMAPEDIATRICS.2019.4488
Vaala, S.E., & Hornik, R.C. (2014). Predicting US Infants' and Toddlers' TV/Video Viewing Rates: Mothers' Cognitions and Structural Life Circumstances. Http://Dx.Doi.Org.Tilburguniversity.Idm.Oclc.Org/10.1080/17482798.2013.824494, 8(2), 163–182. https://doi.org/10.1080/17482798.2013.824494.
Vandewater, E.A. (2011). Infant Word Learning From Commercially Available Video In The US. Http://Dx.Doi.Org.Tilburguniversity.Idm.Oclc.Org/10.1080/17482798.2011.584375, 5(3), 248–266. https://doi.org/10.1080/17482798.2011.584375.
Vedechkina, M., & Borgonovi, F. (2021). A review of evidence on the role of digital technology in shaping attention and cognitive control in children. *Frontiers in Psychology, 12*, Article 611155. https://doi.org/10.3389/FPSYG.2021.611155
Wan, M. W., Fitch-Bunce, C., Heron, K., & Lester, E. (2021). Infant screen media usage and social-emotional functioning. *Infant Behavior and Development, 62*, Article 101509. https://doi.org/10.1016/J.INFBEH.2020.101509
Wang, F., Xie, H., Wang, Y., Hao, Y., & An, J. (2016). Using touchscreen tablets to help young children learn to tell time. *Frontiers in Psychology, 7*(NOV), 1800. https://doi.org/10.3389/FPSYG.2016.01800
Wartella, E., Rideout, V., & Lauricella, A. (2014). Parenting in the Age of Digital Technology. ⟨https://cmhd.northwestern.edu/wp-content/uploads/2015/06/ParentingAgeDigitalTechnology.REVISED.FINAL_.2014.pdf⟩.
WHO, W. H. O. (2019). Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age.
Wiltshire, C. A., Troller-Renfree, S. v, Giebler, M. A., & Noble, K. G. (2021). Associations among average parental educational attainment, maternal stress, and infant screen exposure at 6 months of age. *Infant Behavior and Development, 65*, Article 101644. https://doi.org/10.1016/J.INFBEH.2021.101644
Wong, R. S., Tung, K. T. S., Rao, N., Leung, C., Hui, A. N. N., Tso, W. W. Y., Fu, K. W., Jiang, F., Zhao, J., & Ip, P. (2020). Parent technology use, parent-child interaction, child screen time, and child psychosocial problems among disadvantaged families. *The Journal of Pediatrics*. https://doi.org/10.1016/j.jpeds.2020.07.006
Xie, H., Peng, J., Qin, M., Huang, X., Tian, F., & Zhou, Z. (2018). Can touchscreen devices be used to facilitate young children's learning? A meta-analysis of touchscreen learning effect. *Frontiers in Psychology, 9*(DEC). https://doi.org/10.3389/FPSYG.2018.02580
Yadav, S., Chakraborty, P., Mittal, P., & Arora, U. (2018). Children aged 6–24 months like to watch YouTube videos but could not learn anything from them. *Acta Paediatrica, 107*(8), 1461–1466. https://doi.org/10.1111/APA.14291

Zack, E., Gerhardstein, P., Meltzoff, A. N., & Barr, R. (2013). 15-month-olds' transfer of learning between touch screen and real-world displays: Language cues and cognitive loads. *Scandinavian Journal of Psychology, 54*(1), 20–25. https://doi.org/10.1111/SJOP.12001

Zeng, N., Ayyub, M., Sun, H., Wen, X., Xiang, P., & Gao, Z. (2017). Effects of physical activity on motor skills and cognitive development in early childhood: A systematic review. *BioMed Research International, 2017*. https://doi.org/10.1155/2017/2760716

Ziemer, C. J., & Snyder, M. (2016). A picture you can handle: Infants treat touch-screen images more like photographs than objects. *Frontiers in Psychology, 7*(AUG), 1253. https://doi.org/10.3389/FPSYG.2016.01253/BIBTEX

Zins, J. E., Bloodworth, M. R., Weissberg, R. P., & Walberg, H. J. (2007). The scientific base linking social and emotional learning to school success. *Journal of Educational and Psychological Consultation, 17*(2–3), 191–210. https://doi.org/10.1080/10474410701413145