

CHAPTER 1

Screen Media and the Youngest Viewers: Implications for Attention and Learning

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Children under 2 years of age currently have unprecedented access to electronic media. A series of reports from large-scale surveys of parents indicate that from about 3 months of age most infants have been exposed to some television or video and that by age 2 years about 90% are regular viewers and spend about 1–2 h a day watching (Barr, Danziger, Hilliard, Andolina, & Ruskis, 2010; Linebarger & Vaala, 2010; Rideout & Hamel, 2006; Radesky, Silverstein, Zuckerman, & Christakis, 2014; Schmidt, Rich, Rifas-Shiman, Oken, & Taveras, 2009; Valkenburg et al., 2007; Zimmerman, Christakis, & Meltzoff, 2007b). More recent reports from *Common Sense Media* indicate that children under 2 years currently watch slightly less traditional TV and DVD material (about 56 min per day) but are beginning to spend more time viewing with other mobile devices (Rideout, 2013). Although parents report that most of the viewing is of child-appropriate material, infants and toddlers are also exposed to an additional 5.5 h daily of “background” TV that is not intended for them specifically but is usually viewed by older children and adults (Lapierre, Piotrowski, & Linebarger, 2012).

This amount of screen media exposure has raised a number of concerns among parents, developmental scientists, and other professionals, prompting both scientific inquiry and a public debate about the positive and negative potential of these media to affect young children’s cognitive and social development. Among the most serious concerns are that the excitement of television with its formal features and rapid pace of scene change might hinder children’s developing attention processes (Christakis, Zimmerman, DiGiuseppe, & McCarthy, 2004), and that television and DVDs are passive media and a poor substitute for the more interactive and brain-enriching activities implicit in social exchanges, language, storybook reading, and play

that are interrupted or displaced by video viewing (Christakis et al., 2009). Collectively, these concerns prompted the *American Academy of Pediatrics* (AAP, 1999) to recommend that children under 2 years of age be discouraged from watching any screen media at all. Although a recent policy statement of the AAP (2011) reaffirmed its original recommendation, parents' ownership of baby media continues (Linebarger & Vaala, 2010; Mol, Neuman, & Strouse, 2014; Rideout, 2013).

On the opposite side of the debate are those who support age-appropriate screen media for infants and toddlers as an opportunity to foster learning and brain development, and many videos either explicitly or implicitly endorse this expectation in their promotional materials (Fenstermacher et al., 2010; Garrison & Christakis, 2005; Vaala & Lapierre, 2014). Although claims about the enrichment value of these media are largely unsubstantiated (Garrison & Christakis, 2005; Hirsh-Pasek et al., 2015; Linebarger & Vaala, 2010), 30% of parents surveyed indicated that learning and brain development were among their primary reasons for providing age-appropriate videos to their infants (Zimmerman, Christakis, & Meltzoff, 2007a; Zimmerman et al., 2007b). Advocates of videos for babies who look to science for guidance point to research showing the: (1) greater readiness for school among preschoolers who watched *Sesame Street* and other educational programs (Anderson, 1998; Mares & Han, 2013; Wright et al., 2001) and (2) positive association between viewing certain types of television content (e.g., *Blue's Clues*; *Dora the Explorer*) and better language development (Anderson & Hanson, 2010; Linebarger & Walker, 2005) and prosocial behavior (Friedrich & Stein, 1973). These findings, along with research that documents infants' and toddlers' remarkable ability to learn and remember (Oakes & Bauer, 2007; Bauer, 2007), make the idea of optimizing early learning using high-quality video material both plausible and appealing to parents.

Over the past decade, research has provided a great deal of information about the potential effects of television and video material on very young children's development, and many of these concerns about attention and learning are now fairly well understood. Predictably, the questions and answers have become more complex as the research focus has shifted from the amount of time children spent viewing video to a number of other variables that are arguably even more important. These include the child's age and cognitive maturity, the content of the program being viewed, and the social context in which viewing occurs (Anderson & Hanson, 2010; Barr, 2013; Linebarger & Vaala, 2010). This literature will be reviewed along with

more recent work on the impact of newer interactive mobile technologies such as tablets, smartphones, and e-storybooks on attention and learning in the youngest viewers.

TELEVISION AND THE DEVELOPMENT OF ATTENTION

Although the construct of attention defies simple definition, there is agreement that it is not a unitary process but comprises several different “varieties of attention” (James, 1890) such as alerting, detection, orienting, selectivity, focusing, shifting, and resisting distraction. Although a number of models of attention have been proposed over the years (see Raz & Buhle, 2006), the Posner and Rothbart (2007) framework is particularly well suited to consider its development. In that view, attention is made up of three independent through interactive networks: alerting, orienting, and executive control, each with its own neural foundation and characteristic behavior. Convergent evidence from behavioral and neuroimaging research indicates that these networks are immature at birth and emerge slowly from endogenous neurobiological processes in interaction with typical sensory, cognitive, and caregiving environments (Posner, 2012; Rothbart & Posner, 2015). The alerting and orienting networks that guide the direction of attention and the selection of targets are the earliest to develop and mature rapidly over the first 6 months. The higher-order executive network provides the basis for the voluntary control of attention that is needed to adapt to the demands of particular situations. This network undergoes a protracted period of development into adolescence, with significant advances between 2 and 7 years of age, although precursor signs of self-regulation appear earlier in infancy (Colombo, 2001; Rothbart & Posner, 2015). The executive attention network is foundational to the emergence of executive functions, those higher-order cognitive processes (i.e., working memory, inhibition, attention flexibility) that underlie children’s capacity for self-regulation, planning, problem solving, and monitoring (Diamond, 2013; Garon, Bryson, & Smith, 2008).

Television and Attention Deficits

Concerns about the impact of television on the development of the attention networks were first raised in the 1970s following the appearance of fast-paced children’s television programming such as *Sesame Street* and a correlated increase in reported attention problems (e.g., distractibility, hyperactivity) in school (Geist & Gibson, 2000; Singer, 1980). Although this

complex question was not resolved at the time (Acevedo-Polakovich, Lorch, & Milich, 2007; Anderson & Hanson, 2010), it received renewed interest in the infant and toddler literature a decade ago with the marketing of television and video programming that specifically targeted that age group. Christakis et al. (2004) analyzed parent-report data from two large-scale surveys and found a significant correlation between the amount of television children viewed at 1 and 3 years of age and subsequent attention problems that were consistent with attention deficit hyperactivity disorder (ADHD). However, their data did not establish a causal link between television viewing and later attention and their criteria for identifying a deficit was very broad. Subsequently, Zimmerman and Christakis (2007) reported that the correlation between the amount of television viewed by children younger than 3 years and later attention was significant only when the content of the programs was categorized as violent entertainment. When the program content was educational or nonviolent entertainment, the correlation was not significant. Moreover, the amount and type of television viewed by 4- to 5-year-olds were unrelated to later attention. The authors concluded that the first 3 years were a sensitive period for potential harm from viewing fast-paced (violent) television, although the absence of an effect among older children implied that the problem may be transitory.

Christakis and Zimmerman suggested that exposure to the unnaturally fast pace of sound and image change in video material during this sensitive period might alter synaptic connections in the neural networks underlying attention and shorten the infant's attention span. Further, they contended that fast pace repeatedly elicited the orienting response at the expense of sustained attention and information processing, compelling infants to stare fixedly at the screen. However, this contention is not consistent with research showing that from as early as 6 months of age, infants regulate their attention during periods of extended viewing. They sustain their attention across changes in the formal features (e.g., pace, sound) of the material and coincident heart-rate decelerations and resistance to distraction during extended looking indicate that they process the material at some level (Richards & Anderson, 2004). Moreover, like older children and adults, infants and toddlers frequently look away from video material as toys or other competing stimuli attract their attention (Barr, Zack, Garcia, & Muentener, 2008; Schmidt, Pempek, Kirkorian, Lund, & Anderson, 2008; Setliff & Courage, 2011).

The initial study by Christakis et al. (2004) was widely cited and attracted media attention. However, most of the reporting overlooked other studies

that used more stringent measures to identify childhood attention problems and failed to support the Christakis et al. interpretation of the data (Miller et al., 2007; Obel et al., 2004; Stevens & Muslow, 2006). The media reports also overlooked alternative explanations for the correlation between television viewing and deficits in attention. These include the fact that children with ADHD may be encouraged to watch television at home because it provides parents a respite from the higher level of care that these children require. Moreover, there is evidence that significant deficits in attention (e.g., ADHD) are attributable largely to neurological and genetic factors and to a lesser extent to biohazard exposure, with social factors being of lesser importance (Barkley, 2006, 2011; Posner, Rothbart, & Sheesh, 2007; Rietveld, Hudziak, Bartels, & van Beijsterveldt, 2004). A reanalysis of the Christakis et al. (2004) data indicated that the relation existed only for the 10% of the sample that viewed more than 7 h of television per day. Also, when certain confounding variables (e.g., maternal education; family income) were controlled, the correlation between TV viewing and attention deficits was no longer significant, regardless of content (Foster & Watkins, 2010).

Television and Executive Functioning

Although there is no compelling evidence that infant and toddler video viewing causes clinically significant attention deficits, several recent reports indicated a relation between early viewing and poorer executive functioning in preschool children. Executive functions underlie children's capacity for self-regulation and emerge from the maturation of the orienting and executive attention networks that enable children to increasingly control the information that they process, focus their attention on the task at hand, and to ignore distractors. Executive functions show rapid growth across the preschool years and are critical for success in many aspects of cognitive and social development and for achievement in school. They are also characteristically poor in children diagnosed with ADHD and some contend that the condition is actually a deficit in executive functioning and self-regulation (Barkley, 2011; Diamond, 2013).

Several recent studies directly assessed the relation between television viewing and the development of executive functions in typically developing children. In these studies, executive functions were assessed with various standard behavioral measures of inhibition, working memory, and attention shifting and through parent rating scales. Barr, Lauricella, Zack, and Calvert (2010) reported that children who were exposed to more adult content

television at age 1 year had poorer executive functions age 4 years. Consistent with this, [Nathanson, Alade, Sharp, Rasmussen, and Christy \(2014\)](#) reported that preschoolers with poorer executive functions had a cumulative history of watching more television from infancy and viewing more television with fast-paced cartoon content than did preschoolers with more mature executive functions. In another study, [Lillard and Peterson \(2011\)](#) measured the immediate effect of exposure to fast-paced cartoons on 4-year-olds' executive functions and found poorer performance compared to those who viewed an educational cartoon or spent time drawing with markers. However, the relation between executive functioning and television viewing is not straightforward, as a subsequently study showed that it was the combination of the fantastical content of the material with the fast pace (rather than the pace per se) that diminished executive functions ([Lillard, Drell, Richey, Bogguszewski, & Smith, 2015](#)). Similarly, [Linebarger, Barr, Lapierre, and Piotrowski \(2014\)](#) reported data from a parent survey in which viewing noneducational foreground television and exposure to background television predicted poorer executive functions in preschoolers, but that certain parenting practices and parent socioeconomic status moderated the relation. Finally, [Radesky et al. \(2014\)](#) reported that infants who had difficulties in self-regulation (fussiness, irritability, poor self-soothing, difficulty with state changes (such as sleep) at 9 months and also at 2 years watched more television than those who did not. This finding suggested that, as for children with diagnosed ADHD, parents of infants with poorer self-regulation may have provided television as a calming strategy for these more difficult children (also see [Thompson, Adair, & Bentley, 2013](#)). In any case, the relation between television viewing and poorer executive functioning in young children is not unidirectional and should be interpreted in the context of the child's temperament and family characteristics, the viewing conditions, and the type of content viewed.

Background Television and Attention

One consequence of young children's immature executive functioning is that they are highly distractible. Research has shown that distractibility decreases across infancy and early childhood, although several endogenous (e.g., attentional state, engagement with the object) and exogenous (e.g., target salience or novelty, continuous or intermittent presence) factors interact with age ([Kannass, Colombo, & Wyss, 2010](#); [Oakes, Kannass, & Shaddy, 2002](#); [Ruff & Capozzoli, 2003](#)). Given the number of external and internal

events to which infants and toddlers are exposed, the ability to direct and sustain attention selectively to some stimuli (e.g., toys) while resisting distraction from others that compete for their attention (e.g., television) is critical for early learning. As about 40% of parents report having the television on most or all of the time in the home independent of anyone watching (Masur & Flynn, 2008; Roberts & Foehr, 2008; Rideout, 2013) concerns have been expressed that the omnipresence of television and other screen media in the home might distract infants and young children from play and other activities (Courage & Setliff, 2010).

Research has confirmed that background television can be a significant source of distraction to young children at play as its formal features are salient, often novel, and signal interesting content. Setliff and Courage (2011) reported that 6-, 12-, and 24-month-olds who were engaged in toy play spent less time attending to the toys when the television was on in the background compared to when it was off (also see Schmidt et al., 2008). Children shifted their gaze from the toys to the television about three times per minute, though 46% of the looks were less than 2-s duration and, likely too short for much information processing. Setliff and Courage (2011) also found that the duration of children's focused attention decreased while the television was on. In contrast, Ruff and colleagues (Ruff & Capozzoli, 2003) found a preservation of focused attention during infants' toy play in an intermittent distractor condition. They suggested that infants might have used lower level processes such as "peripheral narrowing" to restrict their attention the target of interest, to resist distraction and maintain focus on a central activity. As the background television in the Setliff and Courage study provided a continuous and varied source of distraction, it may have provided more stimulation than the infants could tune out (Kannass & Colombo, 2007).

Exactly how, what, or even if young children process information from background television is an important question. It may be that as with older children (Anderson & Lorch, 1983; Hawkins, Pingree, Bruce, & Tapper, 1997; Huston & Wright, 1983; Lorch, Anderson, & Levin, 1979; Lorch & Castle, 1997), infants, and toddlers engage in an active and deliberate viewing strategy of monitoring the television rather than simply being distracted by it. In fact, observations indicate that young children often do continue to engage in cognitive and social activities necessary for healthy development when the television is on. Schmitt, Woolf, and Anderson (2003) reported that 2-year-olds present in a room where mixed content television programming was available did engage in several activities at once and

spent 41% of their time looking at the screen, 39% socializing, 34% in physically activity, and 32% playing with toys. Similarly, [Barr et al. \(2008\)](#) found that about 35% of 12- to 18-month-old infants engaged in some toy play in the presence of an infant-directed video that was provided to them as foreground television. However, whether young children adapt to distractors with intensified focused attention or by selective monitoring, or whether their attention and play are simply disrupted by television remains an empirical question that will likely vary with the child's age, task complexity, and motivation ([Higgins & Turnure, 1984](#)). Finally, it is important to note the evidence that once preschoolers are interrupted from play, they return to it with more superficial engagement (akin to the resumption lag in adults' task switching) than before the distraction ([DiLalla & Watson, 1988](#); [Monsell, 2003](#)).

When background TV is available, parent-child interaction is also diminished. In one study, a negative correlation was found between exposure to background television and time spent reading or being read to in children aged 3–6 years ([Vandewater et al., 2005](#)). More recently, [Kirkorian, Pempek, Murphy, Schmidt, and Anderson \(2009\)](#) compared parent engagement with their 12- to 36-month-old children in a 60-min free play session during which background TV was on during half of the session. Parents interacted significantly less with their infants and toddlers and responded less quickly and less enthusiastically to the child's bids for attention when the television was on compared to when it was off. Parents also used briefer and simpler language with their child when the TV was on. A reanalysis of the language data for quantity (number of words and utterances) and quality (number of new words and length of utterances) showed that background TV reduced the number of words per minute, utterances per minute, and the number of new words spoken ([Pempek, Kirkorian, & Anderson, 2014](#)). These findings are consistent with [Christakis et al. \(2009\)](#) who, using the LENA speech identification software system, reported that television exposure in 2- to 48-month-olds was associated with a 7% decrease in exposure to adult speech for each hour of exposure to television, decreased child vocalization, and decreased conversational turn-taking. They suggested that when the television is on, parents talk less to their children which might contribute to the associations between poorer language development and viewing baby video material ([Zimmerman et al., 2007a](#)) and other poor quality or background television material noted in children under 2 years of age ([Hudson, Fennell, & Hoftyzer, 2013](#); [Tomopoulos et al., 2010](#)). In contrast, a longitudinal survey of the time infants spent viewing television (foreground or background) from 6 months to 2 years of age showed that it

was unrelated to their receptive language skill at age 3 years, even when potentially confounding variables (e.g., maternal education, SES) were controlled (Schmidt et al., 2009).

Collectively, the implications of these studies are significant, as the primary way that infants and toddlers learn language is through exposure to “live” speech and through verbal interactions with others (Kuhl, 2011; Parish-Morris, Golinkoff, & Hirsh-Pasek, 2013; Schneidman, Arroyo, Levine, & Goldin-Meadow, 2013; Weisleder & Fernald, 2013; Werker & Hensch, 2015). Extensive literature has documented strong positive effects of parent-child verbal interactions on child language development, self-regulation, school readiness, and later academic achievement (Hart & Risley, 1995; NICHD Early Child Care Research Network, 2005; Whitehurst & Lonigan, 1998). Verbal response to and expansion of child vocalizations as well as labeling are particularly important and commonly emerge in the context of shared conversations, storybook reading, and play. To the extent that time spent viewing video diminishes these interactions, young children may be at risk for poorer language and literacy outcomes.

In summary, the relation between attention problems in very young children and television viewing is complex and depends on the amount of television viewed, and on the aspect of attention that is considered, how it is assessed, the content viewed, and child characteristics. It appears unlikely that television viewing “causes” either clinically significant ADHD at one extreme or poorer self-regulation in an otherwise typically developing child at the other. Nor is it clear whether toddlers and preschoolers who show poorer executive functions and self-regulation in the early years eventually become children with more serious attention deficits at school age. Finally, given that even typically developing infants and toddlers are highly distractible, exposure to hours of background television is unlikely to facilitate their efforts to focus their attention on the serious business of play. Although it is not entirely clear what or how young children are processing as they play in the presence of television, such “multitasking” will likely result in some response cost, just as with older children and adults (Monsell, 2003; Rosen, 2010).

TELEVISION AND LEARNING

As infants and toddlers are proficient at encoding, storing, and retrieving information about their experiences (Hayne, 2009; Oakes & Bauer, 2007), the anticipation that they might learn from age-appropriate video is logical. Several of the earliest studies used imitation paradigms to examine this question, as very

young children cannot be easily instructed or expected to provide adequate verbal responses (Barr & Hayne, 1999; Hayne, Herbert, & Simcock, 2003; McCall, Parke, & Kavanaugh, 1977; Meltzoff, 1988). Nonverbal responses (e.g., reaching, pointing, looking, head turns, foot kicks) are well developed in infants and toddlers and have provided invaluable insights into their learning and memory processes (Rovee-Collier, Hayne, & Colombo, 2001).

The Video Deficit

A common finding from imitation research was that infants and toddlers did not readily imitate action sequences viewed on video, although they imitated the same actions when viewed live. This “video deficit” (Anderson & Pempek, 2005) was not limited to actions but was also seen with object-retrieval, word-learning, and language-recognition tasks (Kirkorian et al., 2016; Krcmar, Grela, & Lin, 2007; Kuhl, Tsao, & Liu, 2003; Schmitt & Anderson, 2002; Troseth & DeLoache, 1998; Troseth, Saylor, & Archer, 2006). Recently, it has been more accurately called a “transfer deficit” (Barr, 2010). Research has shown that this deficit originates from the well-documented specificity of infant learning whereby the characteristics of the encoding (e.g., video) and retrieval (e.g., real world) contexts must match exactly for learning to be evident and transferable (Barnat, Klein, & Meltzoff, 1996; Hayne, 2009; Rovee-Collier, 1999). Over the course of the second year, infants develop greater “representational flexibility” and only then can they tolerate mismatches between encoding and retrieval contexts and begin to generalize and transfer learned information to new objects and situations. However, the transfer deficit is usually not fully resolved until late in the third year (Barr, 2013; Hayne, 2009).

Research on the video deficit showed that for infants and toddlers, mismatches can arise from immaturities in a number of perceptual, cognitive, and social processes. These include the (1) difficulties they have in equating information obtained from the 2-D video format with the corresponding 3-D live source and vice versa (Barr, 2010; Barr, Muentener, Garcia, Fujimoto, & Chavez, 2007; Troseth & DeLoache, 1998), (2) understanding of dual representation; that the video is a thing in its own right and also represents the same information in the real world (DeLoache et al., 2010; Troseth, 2010), and the (3) fact that their everyday experience with responsive, contingent others tells them that the noncontingent video source is neither real nor directed to them personally and therefore not a source of useful information (Stouse & Troseth, 2014; Troseth, 2010). Mitigation of these

factors (e.g., by repetition of the material, experience with closed-circuit video, embedded verbal prompting cues) improved the performance (e.g., Barr et al., 2007, 2008) but eliminated the advantage of live learning only when the video model interacted contingently with the child and familiarized herself to the child before testing (Troseth et al., 2006). Finally, very young children have limited understanding of the medium and conventions of television itself, the form and function of its formal features, the size, movement, and trajectory of the objects and characters, the format (narrative or expository) of the content delivery, or the interactional quality (noncontingency). Following experience with television and with coincident advances in language, cognition, and social awareness, these limitations become resolved and learning and transfer from video begin to occur (Anderson & Hanson, 2010; Barr, 2010).

Although infants and toddlers do not readily imitate from television before their third year, other behaviors indicate that they are sensitive to its content and can acquire new information from it long before then. In various studies, for example, 12- to 18-month-olds played more with toys that they saw on television than they did with novel toys (McCall et al., 1977); 12-month-olds avoided a novel toy after watching a televised model that showed negative affect toward it (Mumme & Fernald, 2003); 18- but not 14-month-olds showed a visual preference for a novel toy after a televised model engaged infants in joint reference during familiarization with another toy (Cleveland & Striano, 2008); and 18-month-olds who viewed video information related to a forgotten sequence of toy-play events had their recollection of the sequence reinstated (Sheffield & Hudson, 2006). Infants who are only 5 months old can integrate auditory and visual information presented from a video source. For example, they prefer to look at video with coordinated than mismatched image with voice or sound (Hollenbeck & Slaby, 1979; Kuhl & Meltzoff, 1982). By 6 months, they can recognize a video image of their parents and associate them with a familiar label (e.g., mama and papa; Tincoff & Jusczyk, 1999). Although these examples indicate that infants can interpret social cues and can discriminate correspondences between a video image and what it depicts at some level, the precise nature of what they acquire and their understanding of the video events are unclear.

Co-viewing With Young Children

Research has shown that a key factor in mitigating the transfer deficit is the presence of an adult who co-views with the child. Infants are inherently

social beings, and much of their cognitive development emerges in a social context. From birth they are increasingly sensitive and responsive to the social cues they get from others (Baldwin & Moses, 2001; Muir & Nadel, 1998; Walden & Ogan, 1988). Consistent with this, Barr et al. (2008) showed that toddlers who viewed infant-directed videos with their parents looked longer at the videos and were more responsive (e.g., vocalizing, pointing) to them when the parents provided scaffolding (e.g., descriptions, labeling, pointing) during viewing. Even with parents' verbal scaffolding controlled, infants between 18 and 21 months old were more likely to look toward a baby video (and to look longer at it) during free-play immediately following a parent's look toward the video than to do so spontaneously (Demers, Hanson, Kirkorian, Pempek, & Anderson, 2013). Such interactions that direct the child's attention to important content can potentially increase comprehension and learning (Barr et al., 2007).

The critical question was whether parent-child interactions could in fact promote learning from video material. There is abundant evidence that such interactions are fundamental to learning during storybook reading (Bus, Van Ijzendoorn, & Pellegrini, 1995; Fletcher & Reese, 2005). Adults talk to children in more complex ways during storybook reading than they do in other contexts. They use a "dialogic" strategy (Whitehurst & Lonigan, 1998) in which they direct children's attention to the elements of the story, engage them in conversation, ask distancing questions, and provide repetitions, expansions, recasts, and explanations of the story content. These shared reading experiences are associated with better literacy outcomes, word learning, story comprehension, school readiness, and interest in independent reading in later childhood (Mol, Bus, & De Jong, 2009; Whitehurst & Lonigan, 1998).

The results of several studies showed clearly that parent-child interactions can also have a positive impact on learning from video, particularly for children who are older than about 2 years and have begun to overcome the video deficit. In one study, adult scaffolding and contingent responsiveness facilitated 3-year-olds' learning of novel object labels from video and was especially effective if the intervention included dialogic questioning (Strouse, O'Doherty, & Troseth, 2013). Similarly, when 30- to 42-month-olds were taught action verbs either by video alone or through a combination of video and live interaction with an adult about the video content, only the children older than 36 months learned verbs in the video alone condition (Roseberry, Hirsh-Pasek, Parrish-Morris, & Golinkoff, 2009). In another study, 2- to 3-year-olds viewed a picture of an object five

times on a screen while hearing a voice-over label the object. Children were then shown the target object with three distractors and correctly pointed to the target object (Scofield, Williams, & Behrend, 2007). Subsequently, the authors showed that toddlers could also transfer their learning to the live 3-D version of the target among the live distractors (Allen & Scofield, 2010). Stouse and Troseth (2014) reported that 2-year-olds showed reliable transfer of a novel word learned from video to the real object, but only when the parent pointed out that the real object and the video image were “the same.” They concluded that toddlers’ frequent failure to learn from video stemmed from failing to understand the relevance of video to real life, a marker of the video deficit. Similarly, Roseberry, Hirsh-Pasek, and Golinkoff (2014) showed that 24- to 30-month-olds, who experienced a simulated video “chat” in which they were taught novel verbs, were successful only when the video partner interacted contingently with them. O’Doherty, Troseth, Shimpi, Goldenberg, and Akhtar (2011) also showed that 2.5-year-old onlookers could learn a novel word from viewing a shared interaction between two adults on video although they did not learn words from the adults in a passive labeling condition without engagement. Collectively, these experimental studies show that from the age of about 24–30 months, children are able to learn some new words from video and that this is most effective in the presence of an engaging, contingent, supportive adult, and the provision of social cues.

In contrast, there is little evidence that children younger than 2 years learn much language from video, even with parent-child interaction (e.g., Krcmar, 2010, 2011, 2014; Krcmar et al., 2007; Robb, Richert, & Wartella, 2009). Video viewing in these very young children is still dominated by the transfer deficit, and the minimal learning they do show is often more readily learned from a live source (Barr, 2010). Although from birth human infants are biologically predisposed to process speech and language and are remarkably facile in their acquisition of this complex system of rules in just a few short years, their success depends heavily on exposure to and interaction with other talking, engaging “live” humans (Kuhl, 2011; Parish-Morris et al., 2013; Werker & Hensch, 2015).

Language Learning From “Baby” Video

The findings on the transfer deficit did not bode well for infant and toddler learning from television and video. However, the evidence that the video deficit could be lessened by adding social relevancy and contingency from adults

as well as by repetition of the material, motivated researchers to identify the conditions that might optimize such learning. Moreover, many of the seminal studies on the video or transfer deficit did not use actual commercially available television or video content. Instead, they used simple filmed action sequences of playful events that were designed to achieve good experimental control over the format and content of the material so it could be related causally to learning outcomes. In contrast, infants' home viewing includes selections from hundreds of infant-directed television and videos (e.g., *Baby Einstein*; *Sesame Beginnings*; *Brainy Baby*; *BabyFirst TV*) that were especially designed to be highly attractive and engaging to very young children. Many of these videos included explicit or implicit claims that young viewers could make advances in cognitive and social development from viewing. These persuasive but arguably misleading claims have made the baby video market a 100 million dollar industry that continues to show exponential growth (Fenstermacher et al., 2010; Vaala & Lapierre, 2014; Zimmerman et al., 2007b).

The public concern about the widespread use and educational expectations of these videos prompted researchers to evaluate their potential impact and effectiveness. Many of the studies examined word learning, a landmark achievement in this age range that has been targeted in many baby videos. The results of these studies have been mixed. Even the youngest children will attend to video material as its movement, color, and formal features (sound, music, zooms, cuts, rapid scene changes) are attractive to them. However, as their language and story comprehension skills are limited, they are unlikely to follow the narrative content, the story line, or the information or lesson to be learned. This was confirmed in several studies in which groups of infants between 6- and 24-months old were shown comprehensible infant videos (*Sesame Street*, *Teletubbies*) and versions that were made noncomprehensible through distortion of the segments, backward speech, or speech in a foreign language. Infants who were 6- and 12-months old attended equally to both videos, indicating that their attention was guided by the formal features of the videos rather than its content. In contrast, the 18- and 24-month-olds looked longer at the comprehensible than the noncomprehensible videos, once meaningful content became important (Pempek et al., 2010; Richards & Cronise, 2000). Similarly, Kirkorian, Anderson, and Keen (2012) used eye tracking to show that when 12- to 15-month-olds were shown a clip from *Sesame Street*, their gaze pattern was more scattered around the screen than that of older preschoolers. The gaze pattern of the older children more closely followed the action in the story, indicating their greater comprehension of the narrative.

DeLoache et al. (2010) assessed word learning from a commercially available baby video designed to teach language to groups of 12- to 18-month-olds who viewed a DVD 20 times at home over a month. Parents were asked either to sit silently with the child during co-viewing or to interact with the child as they normally would during viewing. None of the infants recognized the target words from the video any better than control babies who had never seen it. Babies who did learn new words were those whose parents had been asked to teach them to their infants in natural everyday contexts over the month. Moreover, parents who had positive attitudes about the value of baby DVDs thought their infants learned more than those who were negative or neutral, indicating that consumers continue to be misled by learning potential of DVDs for infants and toddlers. In another study with children under 2-years old, no word learning occurred after 6 weeks of repeated viewing of baby DVDs with highlighted target words, although after a parent scaffolding condition in which words were labeled, some learning did occur (Robb et al., 2009; Richert, Robb, Fender, & Wartella, 2010). A more recent study examined the effectiveness of a series of learning aids including video material, flash cards, and books that purported to teach infants to read (Neuman, Kaefer, Pinkham, & Strouse, 2014). The authors found that 9- to 18-month-olds whose parents followed the reading program for 7 months did not show evidence of precursor (e.g., letter name, print awareness) or conventional (vocabulary, comprehension) reading skills compared to control infants who did not participate in the reading program. Regardless, parents remained enthusiastic about their infants having learned from the baby media material. These poor language outcomes from baby videos that target language are perhaps not surprising given that content analyses of the language learning strategies used in the videos showed that they were poorly integrated into the material and reflected poor understanding of how infants and toddlers learn (Linebarger & Vaala, 2010; Vaala et al., 2010). In a notable exception to this, Dayanim and Namy (2015) showed that 15-month-olds learned ASL baby signs from commercial infant video viewed repeatedly for 3 weeks. Infants learned both with and without parents support, although there was a trend toward better learning in the support condition.

Collectively, these studies indicate that young children can learn from baby video under certain constrained conditions, but that they do not readily do so, especially before 2 years of age (DeLoache et al., 2010; Krcmar, 2011; Robb et al., 2009). Importantly, even when infants do learn new information there is a video deficit; attenuated learning relative to learning from live

and interactive instruction (Barr & Hayne, 1999; Krcmar et al., 2007). When parents co-view video with their infants and toddlers, scaffold their attention, talk to them about the story using a dialogic approach, young children can learn language from video. However, it does not come easily and these conditions are unlikely to occur when children view commercially available video content at home. Moreover, it is not clear that learning from video provides a better alternative to learning through engaging young children directly. Although parent co-viewing can facilitate infant learning from video, the rate of co-viewing at home is only about 50% (Zimmerman et al., 2007b), so in reality infants and toddlers often view videos alone and without supportive parent interaction.

MOBILE TECHNOLOGIES, ATTENTION, AND LEARNING

Many of the questions that were asked and answered about the effects of television on young children's cognitive and social development in the past are being re-raised, this time regarding newer interactive "screens" such as tablets, smartphones, e-books, and gaming consoles. One reason for this resurgence is that because of their mobility and touch screen capability, these devices are far more invasive in children's daily lives than is television. A report from *Common Sense Media* in 2013 indicated that 0- to 8-year-olds' access to some type of "smart" mobile device increased by 50% over the previous 2 years and that the average amount of time spent using the device tripled in that time frame. Children under 2 years have less access to mobile technologies but 38% have at least used one, a rate significantly up from 10% usage 2 years earlier. Infants and toddlers are very drawn to these devices and seem to be able to tap and swipe a screen even before they have developed fine motor control (Cristia & Seidi, 2015). Indeed, the web is replete with images of infants and toddlers doing just that. A second reason for a renewed inquiry into the potential effects of mobile devices is that unlike television, they are interactive rather than passive media and easy to operate without assistance. As such they hold a significant potential to engage children's attention, respond contingently to them, and to support effective learning (e.g., Mayer, 2005; Troseth, Russo, & Strouse, 2016).

Although the *American Academy of Pediatrics* (AAP, 2011) recently acknowledged this new potential for older children, they continued to recommend that children under 2 years be discouraged from having any screen time. Christakis (2014), a member of the AAP committee that drafted the previous policies on children and the media, questioned this caution.

He argued that newer mobile devices were unlike television as they were reactive, interactive, and motivating and could be tailored to match the individual needs of the child. When judiciously used with carefully designed apps, they may well support learning, especially in conjunction with parent scaffolding and support. The research required to confirm or negate this possibility is ongoing, but [Hirsh-Pasek et al. \(2015\)](#) have proposed detailed guidelines based on what science has told us about learning that will help guide the development and use of educational apps that can optimize and support learning.

In advance of available empirical evidence, a vigorous debate recently emerged in the media when the *Sunday Times* (June 14, 2015) cited researchers at Birkbeck, University of London, as saying that “babies should be exposed to iPads from birth” and that “they learn faster with tablet computers than books”. Although the citations were inaccurate and later retracted, the conversation has continued to grow. One side of the debate is the argument that tablets and other mobile devices are here to stay and that even very young children need to become familiar with them. Further, these devices are seen as providing opportunities for joint use and cooperation during learning activities and provide a greater level of cognitive activity compared to books and toys. This in turn could facilitate sensory, perceptual, motor, and cognitive development ([Karmiloff-Smith, 2015](#)). Others contend that providing toddlers with tablets is “unnecessary, inappropriate, and harmful” ([House, 2015](#)). The case made is that infants and toddlers learn best from engaging, interactive humans and that time spent with any media is that the time taken from these more natural daily exchanges and activities. Moreover, there is no evidence that the “greater level of cognitive activity” provided by media is necessary or helpful and that it may actually be harmful. To resolve some of these issues, Tim Smith and Annette Karmiloff-Smith at Birkbeck initiated the TABLET (Toddler Attentional Behaviors and Learning with Touchscreens) project (see APS Observations, July 2015), the goal of which is to document the role that touch screen devices seem to play in family life and the enthusiasm that children seem to show for them. Important issues to be addressed include whether young children use tablets in a passive or interactive way, whether they use them alone or engaging with others, and the appropriateness of the content and design of the apps that they use (see also [Hirsh-Pasek et al., 2015](#)).

Those who advocate the use of tablets and other devices with very young children suggest that a critical aspect of those devices that make them preferable to television as a support for learning is their characteristic

interactivity. Although there is no evidence from studies with infants and toddlers to support or negate this, evidence from studies with preschoolers on the efficacy of e-storybooks compared to traditional paper books is instructive. These studies showed that language learning and story comprehension from e-books depend on many factors (e.g., number of “hotspots,” whether they are consistent with the story or not, parent scaffolding, the child’s executive functioning), but that even under optimal conditions they do not appear to be superior to traditional paper books (Takacs, Swart, & Bus, 2015). Notably, preschoolers’ experience with e-book reading differs from traditional storybook reading (Lauricella, Barr, & Calvert, 2009; Parish-Morris et al., 2013). For example, they look more often to the adult during traditional reading as the “live” narrator appears to elicit social referencing in a way that the e-narrator does not. The wider implications of this are unclear, but referencing others through eye gaze is an important socially guided form of learning that very young children use in shared contexts to interpret others’ behavior to infer expectations and to guide their own behavior accordingly (Walden & Ogan, 1988). In addition, although adults do engage with children during e-book reading, the interactions differ from those during paper book reading (Lauricella et al., 2009; Parish-Morris et al., 2013). Parents initiate more communication during paper book reading, while children initiate more talk during the e-book (Korat, 2010). Parents also talk more about the book format, the device, or the child’s behavior during e-book reading but ask more questions and provided more evaluative comments during the paper book (Krcmar & Cingel, 2014; Parish-Morris et al., 2013). A potential implication of this “tech talk” during e-book reading is the corresponding reduction in the dialogic style of communication that has been so important to language and literacy outcomes more generally (Fletcher & Reese, 2005). Finally, co-reading can be at odds with e-books that contain interactive features, as both parents and children can become frustrated when the parent’s attempts to read interferes with children’s interactions with the book features (Chiong, Ree, Takeuchi, & Erickson, 2012). Although there are no comparable studies with infants and toddlers, evidence to date does not suggest that e-book use would confer any additional advantage to these younger users.

Although definitive data on all of these questions are pending, there seems to be an expectation that just as the judicious and careful use of interactive mobile devices and gaming platforms has been beneficial to the development of language, literacy, story comprehension, and visual perception in older children (Bavelier, Green, & Dye, 2010; Korat & Shamir, 2012;

Smeets & Bus, 2012), that similar benefits might accrue to younger infants and toddlers. However, the proponents should not overlook the strong evidence that infants and toddlers have a video deficit (even with touch screen technology; Barr, 2010) and they do not really understand the medium of video itself. The fact that infants and toddlers pay avid attention to screens and quickly learn to activate their features should not be interpreted as learning from the content of the app or video (see Pempek et al., 2010). Moreover, as their language, narrative comprehension, and executive functions are immature, the cognitive resources required to navigate the devices might serve to distract very young children and diminish learning. Although these issues can be ameliorated (e.g., with age-appropriate content, parent scaffolding, repetition, adding social cues), there is no compelling evidence that such learning from video is a better option to engaging young children directly. In fact, if these devices are used inappropriately, they might well impede developing attention and self-regulation processes and language acquisition, just as has been documented with television viewing.

REFERENCES

- Acevedo-Polakovich, I. D., Lorch, E. P., & Milich, R. (2007). Comparing television use and reading in children with ADHD and non-referred children across two age groups. *Media Psychology, 9*, 447–472.
- Allen, R., & Scofield, J. (2010). Word learning from videos: More evidence from 2-year-olds. *Infant and Child Development, 19*, 649–660.
- Anderson, D. R. (1998). Educational television is not an oxymoron. *Annals of the Academy of Political and Social Science, 557*, 24–38.
- American Academy of Pediatrics. (1999). Media education. *Pediatrics, 104*, 341–342.
- Anderson, D. R., & Lorch, E. P. (1983). Looking at television: Active or reactive? In J. Bryant & D. R. Anderson (Eds.), *Children's understanding of TV: Research on attention and comprehension* (pp. 1–34). New York: Academic Press.
- American Academy of Pediatrics. (2011). Media use by children under two years. *Pediatrics, 128*, 1–6.
- Anderson, D. R., & Hanson, K. G. (2010). From blooming, buzzing confusion to media literacy: The early development of television viewing. *Developmental Review, 30*, 239–255.
- Anderson, D. R., & Pempek, T. A. (2005). Television and very young children. *American Behavioral Scientist, 48*, 505–522.
- Baldwin, D. A., & Moses, L. J. (2001). Links between social understanding and early word learning: Challenges to current accounts. *Social Development, 10*, 309–329.
- Barkley, R. A. (2006). Etiologies. In R. A. Barkley (Ed.), *Attention-deficit hyperactivity disorder: A handbook of diagnosis and treatment* (3rd ed., pp. 219–247). New York: Guilford Press.
- Barkley, R. (2011). *The important role of executive functioning and self-regulation in ADHD*. Retrieved from http://www.russellbarkley.org/factsheets/ADHD_EF_and_SR.pdf.
- Barnat, S. B., Klein, P. J., & Meltzoff, A. N. (1996). Deferred imitation across changes in context and object: Memory and generalization in 14-month-old infants. *Infant Behavior and Development, 19*, 241–251.

- Barr, R. (2010). Transfer of learning between 2D and 3D sources during infancy: Informing theory and practice. *Developmental Review*, 30, 128–154.
- Barr, R. (2013). Memory constraints on infant learning from picture books, television, and touchscreens. *Child Development Perspectives*, 7, 205–210.
- Barr, R., Danziger, C., Hilliard, M., Andolina, C., & Ruskis, J. (2010a). Amount, content, and context of infant media exposure: A parental questionnaire and diary analysis. *International Journal of Early Years Education*, 18, 107–122.
- Barr, R., & Hayne, H. (1999). Developmental changes in imitation from television during infancy. *Child Development*, 70, 1067–1081.
- Barr, R., Lauricella, A., Zack, E., & Calvert, S. L. (2010b). The relation between infant exposure to television and executive functioning, cognitive skills, and school readiness at age four. *Merrill Palmer Quarterly*, 56, 21–48.
- Barr, R., Muentener, P., Garcia, A., Fujimoto, M., & Chavez, V. (2007). The effect of repetition on imitation from television during infancy. *Developmental Psychobiology*, 49, 196–207.
- Barr, R., Zack, E., Garcia, A., & Muentener, P. (2008). Infants' attention and responsiveness to television increases with prior exposure and parental interaction. *Infancy*, 13(1), 30–56.
- Bauer, P. J. (2007). *Remembering the times of our lives: Memory in infancy and beyond*. Hove, UK: The Psychology Press.
- Bavelier, D., Green, S., & Dye, W. G. (2010). Children wired: For better or for worse. *Neuron*, 67, 692–701.
- Bus, A. G., Van Ijzendoorn, M. H., & Pellegrini, A. D. (1995). Joint book reading makes for success in learning to read: A meta-analysis on intergenerational transmission of literacy. *Review of Educational Research*, 65, 1–21.
- Chiong, C., Ree, J., Takeuchi, L., & Erickson, I. (2012). *Comparing parent-child co-reading on print, basic, and enhanced e-book platforms*. The Joan Ganz Cooney Center.
- Christakis, D. A. (2014). Interactive media use at younger than the age of 2 years. *Pediatrics*, 168, 399–400.
- Christakis, D. A., Gilkerson, J., Richards, J. A., Zimmerman, F. J., Garrison, M. M., Xu, D., Gray, S., & Yapanel, U. (2009). Audible television and decreased adult words, infant vocalizations and conversational turns. *Archives of Pediatric and Adolescent Medicine*, 163, 554–558.
- Christakis, D. A., Zimmerman, F. J., DiGiuseppe, D. L., & McCarthy, C. A. (2004). Early television exposure and subsequent attention problems in children. *Pediatrics*, 113, 708–713.
- Cleveland, A., & Striano, T. (2008). Televised social interaction and object learning in 14- and 18-month-old infants. *Infant Behavior and Development*, 31, 326–331.
- Colombo, J. (2001). The development of visual attention in infancy. *Annual Review of Psychology*, 52, 337–367.
- Courage, M. L., & Setliff, A. E. (2010). When babies watch television: Attention-getting, attention-holding and the implications for learning from video material. *Developmental Review*, 30, 220–238.
- Cristia, A., & Seidi, A. (2015). Parental reports on touch screen use in early childhood. *PLoS One*, 10, e0128338.
- Dayanim, S., & Namy, L. L. (2015). Infants learn baby signs from video. *Child Development*, 86, 800–811.
- DeLoache, J. S., Chiong, C., Sherman, K., Islam, N., Vanderborgt, M., Troseth, G., Strouse, G. A., & O'Doherty, K. (2010). Do babies learn from baby media? *Psychological Science*, 21, 1570–1574.
- Demers, L. B., Hanson, K. G., Kirkorian, H. L., Pempek, T. A., & Anderson, D. R. (2013). Infant gaze following during parent-child coviewing of baby videos. *Child Development*, 84, 591–603.
- Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, 64, 135–168.

- DiLalla, L. F., & Watson, M. (1988). Differentiation of fantasy and reality: Preschoolers' reactions to interruptions in their play. *Developmental Psychology*, 24, 286–291.
- Fenstermacher, S. K., Barr, R., Salerno, K., Garcia, A., Shwery, C. E., Calvert, S., & Linebarger, D. L. (2010). *Infant and Child Development*, 19, 557–576.
- Fletcher, K. L., & Reese, E. (2005). Picture book reading with young children: A conceptual framework. *Developmental Review*, 25, 64–103.
- Foster, E. M., & Watkins, S. (2010). The value of reanalysis: Television viewing and attention problems. *Child Development*, 81, 368–375.
- Friedrich, L. J., & Stein, A. (1973). Aggressive and prosocial television programs and the natural behavior of preschool children. *Monographs of the Society for Research in Child Development*, 38, 1–64.
- Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin*, 134, 31–60.
- Garrison, M. M., & Christakis, D. A. (2005). *A teacher in the living room? Educational media for babies, toddlers and preschoolers (Report)*. The Henry J Kaiser Family Foundation: Children's Digital Media Centers.
- Geist, E. A., & Gibson, M. (2000). The effect of network and public television programs on 4- and 5-year-olds' ability to attend to educational tasks. *Journal of Instructional Psychology*, 27, 250–261.
- Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore, MD: Paul Brooks Publishing Company.
- Hawkins, R., Pingree, S., Bruce, L., & Tapper, J. (1997). Strategy and style in attention to television. *Journal of Broadcasting and Electronic Media*, 41, 245–264.
- Hayne, H. (2009). Memory development in toddlers. In M. L. Courage & N. Cowan (Eds.), *The development of memory in infancy and childhood* (pp. 43–68). Hove, UK: Psychology Press.
- Hayne, H., Herbert, J., & Simcock, G. (2003). Imitation from television in 24- and 36-month-olds. *Developmental Science*, 6, 254–261.
- Higgins, A. T., & Turnure, J. E. (1984). Distractibility and concentration of attention in children's development. *Child Development*, 55, 1798–1810.
- 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. *Psychological Science in the Public Interest*, 16, 3–34.
- Hollenbeck, A. R., & Slaby, R. G. (1979). Infant visual and vocal responses to television. *Child Development*, 50, 41–45.
- House, R. (2015). Toddlers, TV and touchscreens. In *Nursery World*. 21 September issue.
- Hudson, T. M., Fennell, C. T., & Hoftyzer, M. (2013). Quality not quantity of television is associated with bilingual toddlers' vocabulary scores. *Infant Behavior and Development*, 36, 245–254.
- Huston, A. C., & Wright, J. C. (1983). Children's processing of television: The informative functions of formal features. In J. Bryant & D. R. Anderson (Eds.), *Children's understanding of television: Research on attention and comprehension* (pp. 35–68). New York: Academic Press.
- James, W. (1890). *Principles of psychology*. New York, NY: Holt.
- Kannass, K. N., & Colombo, J. (2007). The effects of continuous and intermittent distractors on cognitive performance and attention in preschoolers. *Journal of Cognition and Development*, 8, 63–77.
- Kannass, K. N., Colombo, J., & Wyss, N. (2010). Now pay attention! The effects of instruction on children's attention. *Journal of Cognition and Development*, 11, 509–532.
- Karmiloff-Smith, A. (2015). Toddlers, TV and touchscreens. In *Nursery World*. 21 September issue.
- Kirkorian, H. L., Anderson, D. R., & Keen, R. (2012). Age differences in online processing of video: An eye movement study. *Child Development*, 83, 497–507.

- Kirkorian, H. L., Lavigne, H. J., Hanson, K. G., Troseth, G. L., Demers, L. B., & Anderson, D. R. (2016). Video deficit in toddlers object retrieval: What eye movements reveal about online cognition. *Infancy*, 21, 37–64.
- Kirkorian, H. L., Pempek, T. A., Murphy, L. A., Schmidt, M. E., & Anderson, D. R. (2009). The impact of background television on parent-child interaction. *Child Development*, 80(5), 1350–1359.
- Korat, O. (2010). Reading electronic books as a support for vocabulary, story comprehension, and word reading in kindergarten and first grade. *Computers and Education*, 55, 24–31.
- Korat, O., & Shamir, A. (2012). Direct and indirect teaching: Using e-books for supporting vocabulary, word reading, and story comprehension for young children. *Journal of Educational Computing Research*, 46, 135–152.
- Krcmar, M. (2010). Assessing the research on media, cognitive development, and infants. *Journal of Children and Media*, 4, 119–134.
- Krcmar, M. (2011). Word learning in very young children from infant-directed videos. *Journal of Communication*, 61, 780–794.
- Krcmar, M. (2014). Can infants and toddlers learn words from repeat exposure to an infant-directed DVD? *Journal of Broadcasting and Electronic Media*, 58, 196–214.
- Krcmar, M., & Cingel, D. P. (2014). Parent-child joint reading in traditional and electronic formats. *Media Psychology*, 17, 262–281.
- Krcmar, M., Grela, B., & Lin, K. (2007). Can toddlers learn language from television? An experimental approach. *Media Psychology*, 10, 41–63.
- Kuhl, P. K. (2011). Who's talking? *Science*, 333, 529–530.
- Kuhl, P. K., & Meltzoff, A. N. (1982). The bimodal perception of speech in infancy. *Science*, 218, 1138–1141.
- Kuhl, P. K., Tsao, F. M., & Liu, H. M. (2003). Foreign language experience in infancy: Effects of short-term exposure and social interaction on phonetic learning. *Proceedings of the National Academy of Sciences USA*, 100, 9096–9101.
- Lapierre, M. A., Piotrowski, J. T., & Linebarger, D. L. (2012). Background television in the homes of US children. *Pediatrics*, 130, 1–8.
- Lauricella, A. R., Barr, R., & Calvert, S. L. (2009). Emerging computer skills: Influences of young children's executive functioning abilities and parental scaffolding techniques in the US. *Journal of Children and Media*, 3, 217–233.
- Lillard, A. S., Drell, M. B., Richey, E. M., Bogguszewski, K., & Smith, E. D. (2015). Further examination of the immediate impact of television on children's executive function. *Developmental Psychology*, 51, 792–805.
- Lillard, A. S., & Peterson, J. (2011). The immediate impact of different types of television on young children's executive function. *Pediatrics*, 128, 644–649.
- Linebarger, D. L., Barr, R., Lapierre, M. A., & Piotrowski, J. T. (2014). Association between parenting, media use, cumulative risk, and children's executive functioning. *Journal of Developmental and Behavioral Pediatrics*, 35, 367–377.
- Linebarger, D. L., & Vaala, S. E. (2010). Screen media and language development in infants and toddlers: An ecological perspective. *Developmental Review*, 30, 176–202.
- Linebarger, D. L., & Walker, D. (2005). Infants' and toddlers' television viewing and language outcomes. *American Behavioral Scientist*, 48, 624–645.
- Lorch, E. P., Anderson, D. R., & Levin, S. R. (1979). The relationship of visual attention to children's comprehension of television. *Child Development*, 50, 722–727.
- Lorch, E. P., & Castle, V. J. (1997). Preschool children's attention to television: Visual attention and probe response times. *Journal of Experimental Child Psychology*, 66, 111–127.
- Mares, M. -L., & Han, Z. (2013). Effects of Sesame Street: A meta-analysis of children's learning in 15 countries. *Journal of Applied Developmental Psychology*, 34, 140–151.

- Masur, E. F., & Flynn, V. (2008). Infant and mother–infant play and the presence of the television. *Journal of Applied Developmental Psychology*, 29(1), 76–83.
- Mayer, R. E. (2005). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), *Cambridge handbook of multimedia learning* (pp. 31–48). New York: Cambridge University Press.
- McCall, R. B., Parke, R. D., & Kavanaugh, R. D. (1977). Imitation of live and televised models by children one to three years of age. *Monographs of the Society for Research in Child Development*, 42, [5, serial no. 173].
- Meltzoff, A. N. (1988). Imitation of televised models by infants. *Child Development*, 64, 80–89.
- Miller, C. J., Marks, D. J., Miller, S. R., Berwid, O. G., Kera, E. C., Santra, A., & Halperin, J. M. (2007). Television viewing and risk for attention problems in preschool children. *Journal of Pediatric Psychology*, 32, 448–452.
- Mol, S. E., Bus, A. G., & De Jong, M. T. (2009). Interactive book reading in early education: A tool to stimulate print knowledge as well as oral language. *Review of Educational Technology and Research*, 79, 979–1007.
- Mol, S. E., Neuman, S. B., & Strouse, G. A. (2014). From ABCs to DVDs: Profiles of infants' home media environments in the first two years of life. *Early Child Development and Care*, 184, 1250–1266.
- Monsell, S. (2003). Task switching. *Trends in Cognitive Sciences*, 7, 134–140.
- Muir, D., & Nadel, J. (1998). Infant social perception. In A. Slater (Ed.), *Perceptual development: Visual, auditory, and speech perception in infancy* (pp. 247–286). Hove, UK: Psychology Press.
- Mumme, D. L., & Fernald, A. (2003). The infant as onlooker: Learning from emotional reactions observed I a television scenario. *Child Development*, 74, 221–237.
- Nathanson, A. I., Alade, F., Sharp, M. L., Rasmussen, E. E., & Christy, K. (2014). The relation between television exposure and executive function among preschoolers. *Psychology*, 50, 1497–1506.
- Network, N. I. C. H. D. E. C. C. (2005). Predicting individual differences in attention, memory, and planning in first graders from experiences at home, child care, and school. *Developmental Psychology*, 41, 99–114.
- Neuman, S. b., Kaefer, T., Pinkham, A., & Strouse, G. A. (2014). Can babies learn to read? A randomized trial of baby media. *Journal of Educational Psychology*, 106, 815–830.
- Oakes, L. M., & Bauer, P. J. (2007). *Short- and long-term memory in infancy and early childhood*. Oxford: New York.
- Oakes, L. M., Kannass, K. N., & Shaddy, D. J. (2002). Developmental changes in endogenous control of attention: The role of target familiarity on infants' distraction latency. *Child Development*, 73(6), 1644–1655.
- Obel, C., Henriksen, T. B., Dalsgaard, S., Linnet, K. M., Skajaa, E., Thomsen, P. H., & Olsen, J. (2004). *Pediatrics*, 144(5), 1372–1373 Does children's watching of television cause attention problems? Retesting the hypothesis in a Danish cohort.
- O'Doherty, K., Troseth, G., Shimpi, P. M., Goldenberg, E., & Akhtar, N. (2011). Third-party social interaction and word learning from video. *Child Development*, 82, 902–915.
- Parish-Morris, J., Golinkoff, R. M., & Hirsh-Pasek, K. (2013). From coo to code: A brief history of language development. In P. D. Zelazo (Ed.), *Vol.1. The Oxford handbook of developmental psychology* (pp. 867–901). New York: Oxford University Press.
- Pempek, T. A., Kirkorian, H. L., & Anderson, D. L. (2014). The effects of background television on the quantity and quality of child-directed speech by parents. *Journal of Children and Media*, 8, 211–222.
- 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*, 4, 1283–1293.

- Posner, M. (2012). *Attention in a social world*. Oxford: New York.
- Posner, M. I., & Rothbart, M. K. (2007). *Educating the human brain*. Washington, DC: American Psychological Association.
- Posner, M. I., Rothbart, M. K., & Sheesh, B. E. (2007). Attention genes. *Developmental Science*, 10, 24–29.
- Radesky, J. S., Silverstein, M., Zuckerman, B., & Christakis, D. A. (2014). Infant self-regulation and early childhood media exposure. *Pediatrics*, 133, 1172–1178.
- Raz, A., & Buhle, J. (2006). Typologies of attention networks. *Nature Reviews Neuroscience*, 7, 367–379.
- Richards, J. E., & Anderson, D. R. (2004). Attentional inertia in children's extended looking at television. *Advances in Child Development and Behavior*, 32, 163–212.
- Richards, J. E., & Cronise, K. (2000). Extended visual fixation in the early preschool years: Look duration, heart rate changes, and attentional inertia. *Child Development*, 71(3), 602–620.
- Richert, R. A., Robb, M. B., Fender, J. E., & Wartella, E. (2010). Word learning from baby videos. *Archives of pediatric and adolescent medicine*, 164, 432–437.
- Rideout, V. (2013). *Zero to eight: Children's media use in America 2013*. San Francisco, CA: Common Sense Media.
- Rideout, V. J., & Hamel, V. (2006). *The media family: Electronic media in the lives of infants, toddlers, preschoolers, and their parents (Report)*. Oakland, CA: The Henry J. Kaiser Family Foundation: Children's Digital Media Centers.
- Rietveld, M. J. H., Hudziak, J. J., Bartels, M., & van Beijsterveldt, C. E. M. (2004). Heritability of attention problems in children: Longitudinal results from a study of twins aged 3 to 12. *Journal of Child Psychology and Psychiatry*, 45, 577–588.
- Robb, M., Richert, R., & Wartella, E. (2009). Just a talking book? Word learning from watching baby videos. *British Journal of Developmental Psychology*, 27, 27–45.
- Roberts, D. F., & Foehr, U. G. (2008). Trends in media use. *The Future of Children*, 18, 11–37.
- Roseberry, S., Hirsh-Pasek, K., & Golinkoff, R. M. (2014). Skype me! Socially contingent interactions help toddlers learn language. *Child Development*, 85, 956–970.
- Roseberry, S., Hirsh-Pasek, K., Parrish-Morris, J., & Golinkoff, R. M. (2009). Live action: Can young children learn verbs from video? *Child Development*, 80, 1360–1375.
- Rosen, L. D. (2010). *Rewired: Understanding the i-generation and the way they learn*. New York: Palgrave Macmillan.
- Rothbart, M. K., & Posner, M. I. (2015). The developing brain in a multitasking world. *Developmental Review*, 35, .
- Rovee-Collier, C. (1999). The development of infant memory. *Current Directions in Psychological Science*, 8, 80–85.
- Rovee-Collier, C., Hayne, H., & Colombo, M. (2001). *The development of implicit and explicit memory*. Amsterdam: J. Benjamins.
- Ruff, H. A., & Capozzoli, M. C. (2003). Development of attention and distractibility in the first 4 years of life. *Developmental Psychology*, 39(5), 877–890.
- Schmidt, M., Pempek, T. A., Kirkorian, H. L., Lund, A. F., & Anderson, D. R. (2008). The effects of background television on the toy play behavior of very young children. *Child Development*, 79(4), 1137–1151.
- Schmidt, M. E., Rich, M., Rifas-Shiman, S. L., Oken, E., & Taveras, E. M. (2009). Television viewing in infancy and child cognition at 3 years of age in a US cohort. *Pediatrics*, 123, 370–375.
- Schmitt, K. L., & Anderson, D. R. (2002). Television and reality: Toddlers use of visual information from video to guide behavior. *Media Psychology*, 4, 51–76.

- Schmitt, K. L., Woolf, K. D., & Anderson, D. R. (2003). Viewing the viewers: Viewing behaviors by children and adults during television programs and commercials. *Journal of Communication*, 53(2), 265–281.
- Schneidman, L. A., Arroyo, M. E., Levine, S. C., & Goldin-Meadow, S. (2013). What counts as effective input for word learning? *Journal of Child Language*, 40, 672–686.
- Scofield, J., Williams, A., & Behrend, D. A. (2007). Word learning in the absence of a speaker. *First Language*, 27, 297–311.
- Setliff, A. S., & Courage, M. L. (2011). Background television and infants' allocation of their attention during toy play. *Infancy*, 16, 611–639.
- Sheffield, E. G., & Hudson, J. A. (2006). You must remember this: Effect of video and photograph reminders on 18-month-olds event memory. *Journal of Cognition and Development*, 7, 73–93.
- Singer, J. I. (1980). The power and limitations of television: A cognitive affective analysis. In P. H. Tannenbaum & R. Ableles (Eds.), *The entertainment functions of television*. Hillsdale, NJ: Lawrence Erlbaum.
- Smeets, D. J. H., & Bus, A. (2012). Interactive electronic storybooks for kindergarteners to promote vocabulary growth. *Journal of Experimental Child Psychology*, 112, 36–55.
- Stevens, T., & Muslow, M. (2006). There is no meaningful relation between television exposure and the symptoms of attention-deficit/hyperactivity disorder. *Pediatrics*, 117, 665–672.
- Stouse, G. A., & Troseth, G. L. (2014). Supporting toddlers' transfer of word learning from video. *Cognitive Development*, 30, 47–64.
- Strouse, G. A., O'Doherty, K., & Troseth, G. L. (2013). Effective co-viewing: Preschoolers' learning from a video after a dialogic questioning intervention. *Developmental Psychology*, 49, 2368–2381.
- Takacs, Z. K., Swart, E. K., & Bus, A. G. (2015). Benefits and pitfalls of multimedia and interactive features in technology-enhanced storybooks: A meta-analysis. *Review of Educational Research*, 20, 1–42.
- Thompson, A. L., Adair, L. S., & Bentley, M. E. (2013). Maternal characteristics and perceptions of temperament associated with infant TV exposure. *Pediatrics*, 131.
- Tincoff, R., & Jusczyk, P. W. (1999). Some beginning of word comprehension in 6-month-olds. *Psychological Science*, 10, 172–175.
- Tomopoulos, S., Dreyer, B. P., Berkule, S., Fierman, A. H., Brockmeyer, C., & Mendelsohn, A. L. (2010). Infant media exposure and toddler development. *Archives of Pediatric and Adolescent Medicine*, 164, 1105–1111.
- Troseth, G. L. (2010). Is it life or is it Memorex? Video as a representation of reality. *Developmental Review*, 30, 155–175.
- Troseth, G. L., & Deloache, J. S. (1998). The medium can obscure the message: Young children's understanding of video. *Child Development*, 69, 950–965.
- Troseth, G. L., Russo, C. E., & Strouse, G. A. (2016). What's next for research on young children's interactive media? *Journal of Children and Media*, 10, 54–62.
- Troseth, G. L., Saylor, M. M., & Archer, A. H. (2006). Young children's use of videos as a source of socially relevant information. *Child Development*, 77, 786–799.
- Vaala, S. E., & Lapierre, M. A. (2014). Marketing genius: The impact of educational claims and cues on parents' reactions to infant/toddler DVDs. *The Journal of Consumer Affairs*, 48 (2), 323–350.
- Vaala, S. E., Linebarger, D. L., Fenstermacher, S. K., Tedone, A., Brey, E., Barr, R., Moses, A., Shwery, C. E., & Calvert, S. L. (2010). Content analysis of language-promoting teaching strategies used in infant-directed media. *Infant and Child Development*, 19, 628–648.

- Valkenburg, E. A., Rideout, V. J., Wartella, E. A., Huang, X., Lee, J. H., & Shim, M. (2007). Digital childhood: Electronic media and technology use among infants, toddlers, and preschoolers. *Pediatrics*, *119*(5), 1006–1015.
- Vandewater, E. A., Bickham, D. S., Lee, J. H., Cummings, H. E., Wartella, E. A., & Rideout, V. J. (2005). When the television is always on: Heavy television exposure and young children's development. *American Behavioral Scientist*, *48*(5), 562–577.
- Walden, T., & Ogan, Y. (1988). The development of social referencing. *Child Development*, *59*, 1230–1240.
- Weisleder, A., & Fernald, A. (2013). Talking to children matters: Early language experience strengthens processing and builds vocabulary. *Psychological Science*, *24*, 2143–2152.
- Werker, J. F., & Hensch, T. K. (2015). Critical periods in speech perception: New directions. *Annual Review of Psychology*, *66*, 173–196.
- Whitehurst, G. J., & Lonigan, C. J. (1998). Child development and emergent literacy. *Child Development*, *69*, 848–872.
- Wright, J. C., Huston, A. C., Murphy, K. C., St. Peters, M., Pinon, M., Scantlin, R., & Kotler, J. (2001). The relation of early television viewing to school readiness and vocabulary of children from low-income families: The early window project. *Child Development*, *72*, 1347–1366.
- Zimmerman, F. J., & Christakis, D. A. (2007). Associations between content types of early media exposure and subsequent attention problems. *Pediatrics*, *120*, 986–992.
- Zimmerman, F. J., Christakis, D. A., & Meltzoff, A. N. (2007a). Associations between media viewing and language development in children under age 2 years. *Journal of Pediatrics*, *151*, 364–368.
- Zimmerman, F. J., Christakis, D. A., & Meltzoff, A. N. (2007b). Television and DVD/video viewing by children 2 years and younger. *Archives of Pediatric and Adolescent Medicine*, *161*, 437–479.