E-STORYBOOKS AND PAPER STORYBOOKS FOR PRESCHOOLERS: EFFECTS ON ATTENTION, LEARNING AND ENGAGEMENT

by © Anna Richter. A Thesis submitted

to the School of Graduate Studies in partial fulfillment of the

requirements for the degree of Doctor of Psychology

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Memorial University of Newfoundland

2016

St. John's, Newfoundland

Abstract

The increasing availability of electronic storybooks (e-books) for preschoolers has raised a variety of concerns regarding their potential to distract children and diminish pre-reading skill acquisition as well as change the nature of the parent-child interaction during book reading. Alternatively, because e-books are delivered via popular mobile devices, it has been suggested that they might motivate children to read more, allow children to benefit from built-in reading aids, and increase their focused attention to story details. The current study investigated the utility of e-books for facilitating early literacy skills in a sample of 79 3 to 5-year-olds. Children read an e-book and paper storybook with an experimenter and were asked story comprehension questions following each book reading. Children then completed two measures of executive function (Day-Night Task and Digit Span Task) as well a measure of receptive vocabulary. Dependent measures were children's (1) recall of factual and inferred story detail (2) duration of looking to book, adult, and off-task during reading, (3) engagement and communication during story reading. ANOVAs revealed that: (1) there was a significant increase in recall of story information across age, but no difference as a function of story format (2) all children were highly attentive during story reading but looked relatively more at the e-book than the paper book and more at the adult during the paper book reading (3) children were engaged with and communicated about both stories, but more so with the e-book than the paper book. The results of the current study suggest that carefully designed e-books support story comprehension similarly to paper books and also increase children's engagement and communication during book reading.

Acknowledgements

I would like to thank my supervisor, Dr. Mary Courage, for her continued support and guidance throughout the entirety of this project. I am thankful for the opportunity to have been mentored by Dr. Courage and have benefited immensely from her expertise. I would also like to thank my thesis committee members, Dr. Christine Arlett and Dr. Alissa Setliff, for their thoughtful feedback and interest in this area of research. Additionally, I wish to thank the Psy.D. program, both students and faculty, for their support throughout the entire program. I am also thankful for the unwavering support of my parents who encouraged me from the beginning. Finally, I am appreciative of the daycare providers, parents and children who showed an interest in this project and generously volunteered their time to participate.

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E-Storybooks versus Paper Storybooks for Preschoolers: Effects on Attention and Learning

In recent years there has been a trend away from the use of traditional storybooks and towards the use of electronic books (e-books), as electronic devices such as iPads and e-readers have become increasingly accessible (Felvegi & Matthew, 2012). A recent large-scale study involving children ages 6 to 17 and their families indicated 46% of children had read an e-book in 2013, compared to 25% in 2010 (Scholastic, 2013). Over the same three-year period, e-book reading on iPads and e-readers increased significantly (3-21% and 7-19%, respectively; Scholastic, 2013). E-books are digital versions of a story presented on a computer or handheld electronic device, which allow the reader to watch animations, read along with a recorded version of the text and explore interactive features (Moody, Justice & Cabell, 2010). E-books are different from traditional storybooks because they often include interactive "hotspots" such as dictionaries, games, sound effects and definitions. Given the differences between electronic and paper modalities, concerns have been raised by parents and educators regarding the efficacy of e-books for facilitating emergent literacy skills in young children (de Jong & Bus, 2003; Shamir & Korat, 2007). It has been suggested that e-books will negatively impact upon young children's reading skill development by distracting young readers from story content and changing the nature of adult-child interaction during book reading. Conversely, it has been suggested that e-books may increase children's motivation, and they may benefit from built-in reading aids.

Research examining e-books for children is currently in its early stages. Given the diverse quality of e-books and study designs used in prior research, many research

questions remain unresolved (Maynard & Cheyne, 2005). Thus far, research has suggested that well designed e-books can facilitate learning in school-aged children; however less is known about their effectiveness for younger readers (de Jong & Bus, 2004; Maynard & Cheyne, 2005). It has been hypothesized that preschoolers may benefit less from e-books compared to school-age children. Differences in learning between preschool and school age children may be explained by differences in executive functioning, as children under age five have more difficulty maintaining and directing their attention and may therefore be more distracted by e-book features such as interactive "hotspots" (Chiong & DeLoache, 2012). "Hotspots" are embedded interactive features such as sound effects and word repetition that can be activated by the child during book reading. Additionally, qualities of the e-book (e.g. number of interactive features) may further impact upon the ability of a child to develop pre-literacy skills during e-book reading. The aim of the current study was to clarify some of these important issues raised in previous literature regarding the utility of e-books for young readers. In the following sections, the literature to date will be reviewed and current research questions will be defined.

Storybook Reading

The current research questions regarding e-books for young readers must be understood within the broader context of the literature on storybook reading. Early storybook reading is associated with a wide range of positive developmental outcomes. Most importantly, storybook reading plays a critical role in the development of young children's language and literacy. Commonly, storybook reading is associated with an important skill developed in the early kindergarten years: learning to read. Previous

research indicates that vocabulary development plays a central role in learning to read (Bus, van IJzendoorn & Pellegrini, 1995; National Institute of Child Health and Human Development, 2000). Storybooks facilitate vocabulary development by exposing children to new vocabulary and letter-sound associations, which after repeated encounters with new words, expands their vocabulary (Sulzby, 1985; Verhallen, Bus & de Jong, 2006). Meta-analytic research supports the importance of storybook reading in learning to read and indicates that exposure to storybooks is associated with increased vocabulary and reading ability (Bus et al., 1995). In addition to fostering literacy skills through exposure to new vocabulary, storybook reading plays an important role in children's early development of attention, memory and learning (National Institute of Child Health and Human Development, 2000). During book reading, children must learn to maintain focused attention on the book pages and attend to illustrations. Children also develop and utilize their memory, as they must remember information presented on each page in order to follow the story. Finally, children may also learn new information from the content of the storybook. Taken together, research to date places strong emphasis on the importance of early book reading for a range of developmental outcomes. There is also evidence that gains from early exposure to books persist far beyond the early developmental years. In a meta-analysis, Mol and Bus (2011) determined that print exposure during the preschool years is associated with academic achievement in high school and university. They hypothesized that the relationship between early print exposure and academic achievement may be one of reciprocal causation, whereby print exposure increases children's literacy skills and children's literacy skills impact upon the amount of print exposure. Given the multitude of positive outcomes associated with traditional early

book reading and the positive long term outcomes associated with early print exposure, it is important to determine if e-books also facilitate these same outcomes.

E-books and Emergent Literacy

Given the increased use of e-books among children, an emerging area of research is examining the utility of e-books for supporting early literacy development amoung pre-school children. Emergent literacy was first defined by Clay (1967) who described emergent literacy as the developmental precursors to reading, including reading and writing behaviours acquired prior to entry into formal education (e.g. alphabet recognition, phonological awareness) (Salmon, 2014). Literacy development refers to the process of learning to read, which occurs in the early elementary school years. Literacy includes varied skills such as knowledge of print, phonological awareness, comprehension, vocabulary and word reading (Salmon, 2014). E-books have features that may help to facilitate literacy skills, such as narrated text, highlighted text, dictionaries and sound effects presented in a variety of modalities. Recent research on emergent literacy in school-age children suggests that e-books facilitate a variety of literacy skills including phonological awareness (Chera & Wood, 2003), word recognition (de Jong & Bus 2002; Lewin 2000), word meaning (Korat & Shamir, 2012), comprehension (Doty, Popplewell & Byers, 2001) and vocabulary (Ihmeideh, 2014). Research comparing literacy outcomes for kindergarten and school-age children during e-book and paper book reading has revealed mixed findings, with results suggesting that e-books enhance learning (Maynard & Cheyne, 2005; Shamir & Korat, 2007), produce literacy outcomes similar to paper books in kindergarten children (de Jong & Bus, 2004; Grimshaw, Dungworth, McKnight, & Morris, 2007), and hinder learning (Tare, Chiong,

Ganea, & DeLoache, 2010; Smeets & Bus, 2012; de Jong & Bus, 2002). These varied outcomes may be explained by the wide range of e-books and study designs utilized and will be further discussed in the following sections.

Additionally, e-books may be used in educational settings to supplement traditional reading materials and facilitate emergent literacy. A new area of research is emerging that examines the integration of electronic reading material into elementary school classrooms. E-books are advantageous because they are portable, cost effective and many books can be stored on a single device (Felvegi & Matthew, 2012). Previous research suggests that carefully designed e-books can facilitate emergent literacy when used both individually, in pairs, and in group work in a classroom setting (Shamir & Korat, 2007; Lewin, 2000). A meta-analysis of primary school children's comprehension and word-decoding suggests that e-books have a small effect on increasing children's comprehension (Zucker, Moody & McKenna, 2009).

Special populations. Initial research suggests that, in comparison to their same-age peers, kindergarten children from low socio-economic backgrounds may receive additional benefits from reading e-books (Korat & Shamir, 2008; Shamir & Baruch, 2012; Verhallen et al., 2006). Previous research has established that socioeconomic status effects literacy development in part because children from low socio-economic backgrounds may have less access to literacy tools such as books and may experience different types of adult-child interaction during book reading (Korat & Shamir, 2008). Among preschoolers from low socioeconomic backgrounds, e-books have been found to facilitate persistence with the task of reading (Moody et al., 2010) as well as emergent literacy (Talley, 1994; Shamir & Korat, 2007). Among school-age children, e-books

have been found to facilitate vocabulary as well as math skills (Grant, 2004; Shamir & Baruch, 2012). In a study of Dutch children at risk for school failure it was found that children benefited from repeated encounters with e-books more than traditional books (Verhallen et al., 2006). It has been proposed that e-books may be more beneficial for young readers because they require less support from adults and can be read independently. Previous research has found that parent-child reading is less effective in facilitating literacy skills in groups from low socio-economic status compared to controls. It has been hypothesized that differences in parental reading levels across socio-economic groups and children's inability to comprehend and benefit from extra-textual questions posed by their parents may explain observed differences (Mol et al., 2008).

It has also been hypothesized that e-books may be especially useful for children at-risk for developing learning disabilities. It has been suggested that the multi-modal nature of e-books explain their enhanced value for this group of children. E-books present information in a variety of modalities including visual, auditory and sensory, which allows children with deficits in one of these areas to compensate by utilizing information from another modality (Shamir and Baruch, 2012). Further, the interactive nature of e-books has been shown to assist children in maintaining sustained attention and persistence during the reading process. Children at-risk for learning learning disabilities may be especially susceptible to frustration and inattention, therefore these characteristics of e-books make them especially valuable (Moody et al, 2010). Preliminary research has examined the utility of e-book for children diagnosed with learning disabilities. This research suggests that e-books may be useful learning tools for children diagnosed with specific learning disabilities, such as children with language impairment (dyslexia).

Smeets and colleagues (2012) found that although children with speech language impairments did not learn at the same rate as their typically developing peers, significant improvements in expressive vocabulary occurred after repeated exposure to an e-book. Further, children with speech language impairments tended to benefit from visual video learning but were distracted by background music and sounds.

In addition to children at risk for learning disabilities, interactive e-books may be beneficial for children with Attention Deficit Hyperactivity Disorder and Autism Spectrum Disorder. Although no empirical studies have examined e-books use among these populations, research using interactive media provides preliminary evidence that e-books may be beneficial. Cardon and colleagues (2010) found that iPads were useful for facilitating modeling behaviours among preschool children diagnosed with Autism Spectrum Disorder. Research to date suggests that children diagnosed with ADHD may benefit from interactive e-books due to their preference for screen media. Children with ADHD spend more time watching television and less time reading than their typically developing peers (Acedvedo-Polakovick et al, 2007). It has been proposed that children with ADHD have a preference for visual media because of the frequent distractions and face-paced nature of the media. Based on this literature from television, it is anticipated that children with ADHD would be especially interested in using interactive electronic technology for learning.

Taken together, findings from research examining emergent literacy outcomes suggest that e-books facilitate a variety of literacy skills in school-age children and can be used effectively in academic environments. Further, there is preliminary evidence to

suggest that e-books may be especially beneficial for children from some populations including: low socio-economic status, children at-risk for learning challenges, children diagnosed with Learning Disabilities and Autism Spectrum Disorder.

Interactive Features of E-books

A significant difference between e-books and storybooks is the presence of interactive features, or "hotspots", such as games, dictionaries, sound effects, text repetition and animations. These features allow the reader to interact with the story by using the touch screen of the electronic book or the mouse of a computer. Results of content analyses of e-books for children ages 3 to 7 revealed that e-books vary in the types and quantity of interactive features (de Jong and Bus, 2003; Korat and Shamir, 2004). For example, although some e-books may be limited to only sound effects others have built-in games for the child to engage in throughout story reading. Given the wide variety of interactive features present in e-books, there is significant variability in the quality of e-books currently available, which has contributed to the diverse findings to date regarding outcomes from e-book reading (de Jong and Bus, 2003; Korat and Shamir, 2004). Salmon (2014), in a review of the literature with a target population of early childhood (defined as 3- to 7-year olds), identified a variety of factors that impact e-book reading and established that the educational value of e-books is influenced by the type of interactive features present.

Based upon the research to date, it has been suggested that hotspots that are congruent with story content facilitate learning, while incongruent hotspots distract children from the story content and do not provide valuable additional information to facilitate learning. Congruent hotspots are those interactive features that direct the child's

attention to information that is relevant to the story, while incongruent hotspots contain extra information that is not directly related to the story. In a review of literature regarding e-book use in schools, Moody, (2010) found that e-books with interactive features unrelated to story content were distracting and did not facilitate emergent literacy among kindergarten children. It has been suggested that kindergarten children become "passive" readers when engaging with incongruent hotspots because these hotspots do not require them to draw connections to the storyline (de Jong & Bus, 2004). Similarly, congruency between pictures and text has also been found to impact pre-school age readers such that pictures that are incongruent with the storyline have been found to confuse children and detract from learning (de Jong & Bus, 2002).

Beyond the congruency of interactive features, the specific types of feature also impact upon the educational value of e-books. Research to date suggests that interactive games in e-books do not enhance children's comprehension and learning (Grimshaw et al., 2007). When interactive games are present in e-books they tend to distract readers from the content of the story, rather than support learning. Even if the content of a game is related to the content of the story, children fail to learn from interactive games (de Jong & Bus, 2002). In de Jong and Bus' 2002 study, children who read e-books with games spent approximately half of their time engaged in games and therefore, did not have sufficient time to engage with the written text. It has been suggested that when children engage in game-play during reading, they begin to view the story as a game, which can impede story comprehension (Smith, 2001). Additionally, interactive features may distract young readers. In one series of studies, interactive features designed to facilitate learning caused a distraction for readers (Trushell, Burrell, & Maitland, 2001; Trushell,

Maitland, & Burrell, 2003). Children who read an e-book with interactive features recalled significantly less information about the story than children who read the same book without interactive features. The interactive features in the e-book used by Trushell and colleagues included animations and sound effects and 75% of the features were found to be irrelevant to the story line (Trushell et al., 2003). In another study, children were given the option to use interactive "hotspots" at their leisure. Children who engaged with more "hot spots" recalled less story content. It has been suggested that when reading e-books, children may rely too much on the interactive features of the text, resulting in passive, rather than active, engagement with the book (Felvegi & Matthew, 2012). Chiong and colleagues (2012) found that compared to simple e-books, e-books enhanced with diverse interactive features caused distraction. For example, children and parents engaged in more non-content related activities and subsequently, children scored poorer on a measure of story comprehension when utilizing enhanced e-books. In sum, interactive features that include time consuming games or numerous features do not facilitate children's story comprehension and distract children from story content.

In contrast, e-books with carefully designed interactive features have been found to enhance learning, especially among school-age children at risk for learning disabilities (Maynard & Cheyne 2005; Shamir & Baruch, 2012; Verhallen, Bus & de Jong, 2006). In recognition of the wide range of e-book features available for young readers, Shamir and Korat (2007) developed an e-book for use in their research on the efficacy of e-books for facilitating emergent literacy among low SES Israeli school children. Using an e-book with appealing animations, highlighted text and dictionary features, the authors established that children benefit from well-designed e-books, as evidenced by

improvements in a range of emergent literacy skills including word meaning, word recognition and phonological awareness. When multimedia features dramatizing story events are utilized, children benefit from additional gains in vocabulary, syntax and story understanding (Verhallen et al., 2006). Regarding story understanding, children who read a book with multimedia features develop a stronger understanding of implicit story themes (e.g. emotions, motives of protagonist) when asked to retell the story (Verhallen et al., 2006). Beyond literacy development, when e-book features are tailored for use in the classroom to facilitate math skill development, children's vocabulary and early math skills improve significantly compared to traditional classroom teaching (Shamir & Barush, 2012).

Interactive features and young children. The utility of the interactive features of e-books for facilitating learning among younger preschool children has not received attention in the literature to date. Young children benefit most from adult-child interaction, however, less is known about whether interactive electronic features can scaffold children's learning in the same way as adult interaction. Although these research questions have not been examined to date, research conducted using interactive "pop up" picture books suggests that paper books with interactive features are less effective than standard picture books for facilitating learning in preschool children (Tare et al., 2010; Chiong & DeLoache, 2012). "Pop up" picture books have features such as flaps, levers and textures, which allow children to physically interact with the story. In one study, toddlers aged 20 months learned more facts from standard picture books than those with manipulative features (Tare et al., 2010). In another study, 30-36 month old children learned fewer alphabet letters from an interactive book than a standard picture book

(Chiong & DeLoache, 2012). Young children's tendency to learn better from standard picture books suggests that the interactive features of "pop up" books may provide a distraction rather than a learning tool.

The tendency for preschool children to become distracted by interactive features may be explained by immaturities in developing executive attention (see Development of Executive Attention). Preschool children lack the ability to carefully control their attention and may therefore have trouble attending to the story while also engaging in interactive features. Further, playing with features of an interactive book may increase children's cognitive load and require that they split their attention between the interactive features and the story, thus reducing their attention to the story (Tare et al., 2010). The concept of 'dual representation' may further explain children's difficulty in learning from "pop-up" books (DeLoache, 1995). Dual representation is the ability to represent something in two ways simultaneously (e.g. a picture of a boat is a marking on a page and a representation of a physical boat). Cognitive dual representation theory proposes that interesting symbols are more difficult to represent in two ways because more focus is placed on the symbol itself rather than the symbols' representative nature. Research from "pop up" books for toddlers provides support for dual representation theory; children's learning was impaired by the concrete interactive features of the book and they learned to recognize fewer alphabet letters than children who read a non-interactive book (Chiong & DeLoache, 2012).

Previous research suggests that in addition to the potential distraction caused by interactive features, the electronic modality in which e-books are delivered may be disadvantageous for young readers. Research on educational television has consistently

found that in general, children under three years of age learn better from face-to-face interaction than from television. This finding has been termed the "video deficit effect", which describes the tendency for children to learn less readily from video than from live interaction with others. This deficit is present from age 6 months to 3 years, after which point children gradually improve in their ability to learn from television (Barr, 2010). Several hypotheses have been proposed to explain the "video deficit effect". Troseth (2010) proposed that children are not able to effectively learn from television because they are unable to understand that what they view on television is a representation of the real world. Therefore, they have trouble generalizing what they see or learn on television to the world around them. Moreover, people on television do not respond contingently to them as they do in real life. The video-deficit effect may be reduced by parent scaffolding, repetition of information and providing social contingency for learning. This theory from television media also extends to book reading, where young children may have difficulty generalizing learning from books. For very young children, parents are present during reading to scaffold learning and facilitate emergent literacy. Given the previous literature from examining learning from television, we would expect preschoolers' ability to learn from e-books to be similarly impaired.

In order to further understand how generalization of learning from television occurs, other research has taken a different perspective to understand young children's learning. The "perceptual impoverishment hypothesis" explains the video deficit effect in terms of young children's inability to transfer information from 2D to 3D space. The consensus from a review paper (Barr, 2010) provides significant support for this hypothesis and concludes that pre-school children find it easier to transfer learning from

face-to-face interaction compared to television. This hypothesis may be particularly relevant to understanding learning from e-books because, similarly to television, learning from e-books requires the ability to transfer information from a 2D screen to the 3D world around them.

Taken together, research to date outlines how the development executive function, the video deficit effect and perceptual impoverishment hypothesis play a role in young children's ability to learn from screen media.

Development of Executive Function

Executive function refers to "higher order, self-regulatory cognitive processes that aid in the monitoring and control of thought and action" (Carlson, Faja & Beck, 2016, p. 45). In general, executive function refers to adaptive, goal-directed behavior that allows an individual to override more automatic or established thoughts and responses (Garon, Bryson, & Smith, 2008). Children demonstrate dramatic development in this ability between the ages of 3- and 6-years-old. The process by which this complex executive functioning system develops in young children has been explained using varied models. Much of the previous literature has focused on either a unitary development (e.g. via a central attention process) or componential development (e.g. where separate processes such as working memory and inhibition develop on their own trajectories). Miyake et al (2000) first proposed an integrative model, uniting both unitary and componential theories to explain the development of executive functioning. Garon and colleagues (2008) provide strong evidence for the integrative model and provide a strong theoretical foundation for understanding the development of executive functioning. Garon proposes that executive functioning develops via both a unitary process (via the development of

attention) as well as through the development of components of executive function (working memory, response inhibition, set shifting) which is described below.

The development of attention is the unitary process which is foundational to the development of executive functioning (Garon et al, 2008). Before age 1 year, attention remains predominantly controlled by external factors in the environment, such as novelty. Around age one, children begin to develop the ability to exert control over their attention and flexibly shift attention. The ability to control attention continues to develop into the preschool years, as children develop more sophisticated executive control, such as the ability to shift between internal representations and the environment (Garon et al., 2008).

From this attentional system, the basic components of executive function develop including working memory, response inhibition and shifting. Working memory is the ability to hold a representation in memory over a period of time and is commonly conceptualized according to Baddeley's model (1986). This model proposes that a phonological loop stores auditory information, while a visual-spatial sketchpad stores visual-spatial information and these are controlled or overseen by a central executive process. Previous research has concluded that children as young as 6 months of age are able to utilize working memory, though in rudimentary form (Pelphrey & Reznick, 2002). For example, young infants can complete a delayed response task, where a toy is hidden in one of two locations and the infant must select the correct location. Over time, children develop the ability to remember more pieces of information and retain information in memory for longer periods of time. During the preschool years, children rapidly develop more sophisticated working memory skills, such as the ability to update representations held in working memory (Gathercole, 1998 see Garon et al, 2008).

Response inhibition has been more extensively studied in pre-school age children and is an important component of executive functioning that develops throughout the pre-school years. Response inhibition is the ability to withhold a motor, affective or cognitive response. Simple response inhibition, such as the ability to follow a caregiver's request to stop an enjoyable activity, is present before age 1 year. More complex response inhibition, such as the ability to inhibit a behavior according to an arbitrary rule, begins to develop during the preschool years and development is still incomplete by school-age. Complex response inhibition requires additional demands on working memory and is therefore a more advanced skill. Shifting involves shifting from one "mental set" to another. There are two types of set shifting: attention shifting and task shifting. Attention shifting involves learning a new rule for selecting between aspects of a stimulus, while task shifting involves incorporating a rule about a motor response.

Children make dramatic gains in executive functioning during the preschool years (Kraybill & Bell, 2013). Specifically, there are significant improvements in inhibitory control between the ages of 3-5 years. At 3 years of age, less than half of children can master tests of inhibitory control such as the "Day-Night" test, while at age 5 over 80% of children are successful (Kraybill & Bell, 2013). The development of executive attention plays an important role in facilitating a variety of skills including emergent literacy and is strongly associated with school readiness among pre-school children (Diamond, Barnett, Thomas & Munro, 2007).

The role of executive function in e-book reading in relatively unexplored to date. Literature from the effects of television watching on executive function suggests that exposure to television has a detrimental impact on young children's executive function

(Lillard & Peterson, 2011). In the context of the current research, it is hypothesized that the maturity of executive attention may predict children's ability to learn from interactive media such as e-books. E-books require the child to shift attention between the content of the story and the interactive features embedded in the story while holding information about the content of the story in memory. Further, children must learn to focus on the content of the story while selecting which interactive features to use.

Motivation and engagement.

Previous research suggests that interactive features increase children's interest and motivation to read and facilitate children's engagement with book reading (Moody et al., 2010). Reading engagement refers to the level of interest and amount of time children spend reading books and is associated with the development of literacy skills (Jones & Brown, 2011). Additionally, reading engagement is associated with motivation to read and can be predictive of future reading achievement and success with literacy interventions (Justice, Chow, Capellini, Flanigan, & Colton, 2003). Children who are motivated to read spend more time reading and learn faster than their peers. The findings of recent research have clearly demonstrated that hotspots in e-books enhance children's motivation to read (Moody et al., 2010). When compared to a traditional storybook, children reading an e-book show increased persistence with the task of reading, which is associated with increased exposure to books and overall literacy skills (Moody et al., 2010). Additionally, when given the choice between electronic and traditional books, children tend to prefer to use e-books, which may further enhance their motivation to read in electronic format (Jones & Brown, 2011). In educational settings, e-book use has been associated with increased motivation, interaction and co-operation among children

working on group assignments. Additionally, observational data suggest that e-books facilitate structured and productive work among group members (Maynard & Cheyne, 2005). Research to date suggests that children enjoy reading e-books and demonstrate increased motivation and engagement when using interactive features of e-books.

Communication: Parent-Child Interaction during Book Reading

A large body of research suggests that adult-child interaction during book reading is associated with a wide range of positive developmental and educational outcomes including advances in language development, emergent literacy and reading achievement (Bus et al., 1995). Previous research suggests that parents and caregivers facilitate emergent literacy skills such as vocabulary development and story comprehension during book reading by directing their child's attention, providing repetition and explanations, and engaging in conversation (Mol, Bus, de Jong & Sweets, 2008). Whitehurst and colleagues (1988) have provided a significant contribution to this area of literature and provided early support for the importance of parent-child interaction during book reading. Based on the relationship between parent-child interaction and literacy outcomes, Whitehurst designed a dialogic reading intervention that aimed to facilitate parent-child interaction during storybook reading. Through the development of dialogic reading programs, several strategies have been identified that improve children's learning, including asking questions to the child, providing feedback throughout the story, adapting the reading style to suit a child's developmental ability and providing the child with support and information to ensure they understand the story (often referred to as "scaffolding"). The use of extra-textual questions (questions posed by an adult) in dialogic reading programs has been a focus of previous research; these questions draw the

reader's attention to important aspects of the story and test their comprehension (Fletcher & Reese, 2005). Previous research has found that children's vocabulary learning increases up to 18% when extra-textual questions are used (Smeets & Bus, 2012). A meta-analysis of studies using a dialogic reading intervention group and a reading-as-usual control group suggests that dialogic reading programs have a moderate effect on children's vocabulary acquisition (Mol et al., 2008). Dialogic reading has been found to be less effective for facilitating vocabulary learning in children older than 5 years and for children at risk for language and literacy impairments. Older children may require less support during reading, while children at risk for language and literacy impairments may require more tailored interventions during reading and therefore benefit less from dialogic reading. Beyond developing basic literacy skills, the process of reading with an adult facilitates social learning, as adults provide children with extra information to aid their story comprehension and story telling in a social, collaborative atmosphere (Mol et al., 2008).

Given the importance of adult-child interaction during book reading, concern has been raised regarding the efficacy of e-books for facilitating important educational and developmental skills, as e-books may be read alone and require less adult involvement (Felvegi & Matthew, 2012). For example, many e-books can be read independently by using a "read along" feature in which a narrated voice reads the story aloud and interactive features such as dictionary definitions and sound effects provide additional support for understanding story content without the assistance of an adult. Previous literature has established that parent-child interaction facilitates learning; therefore, it has

been suggested that children who read e-books may "miss out" on important social interactions and learning opportunities.

It is notable that, although e-books contain features that allow them to be read independently, they may still be read with the support of an adult. Research to date has established that kindergarten children benefit from adult instruction during e-book reading when compared to solitary e-book reading and make gains in emergent literacy including phonological awareness and word reading when supported by an adult during e-book reading (Segal-Drori, Korat, Shamir & Klein, 2010). Much like during reading with traditional books, parents can facilitate learning during e-book reading by engaging children in conversation and providing repetition and clarification. Similarly to traditional paper book reading, when adults become involved in e-book reading with their children, communicative interactions between the child and adult occur naturally (Moody et al., 2010; de Jong & Bus, 2002). Techniques such as dialogic reading can be used equally with e-books and traditional books to enhance children's learning (Moody et al., 2010). As discussed above, dialogic techniques involve interacting with the child and engaging with them during story reading. Specifically, the use of extra-textual questions has been found to facilitate learning from e-books (Smeets & Bus, 2012). Research from print and electronic books suggests that children benefit from adult interaction and instruction during book reading; therefore, despite the features that allow independent reading with electronic media, adult-led e-book reading is considered beneficial (Chiong, Ree, Takeuchi & Erickson, 2012; Mol et al., 2008).

Given the evidence that adult-led reading facilitates learning from electronic books, researchers have begun to explore the types of adult-child interaction that occur

during e-book reading. To date, little research exists regarding adult-child communication during electronic book reading in an experimental setting. Much of the research has observed parent-child dyads during paper and electronic book reading using an ecologically valid study design where parents were asked to read as they typically would with their children. These studies have concluded that both the quantity of interaction and types of interactions differ during electronic and paper book reading. Parents initiate more communication during paper book reading compared to e-book reading (Kim & Anderson, 2008; Krcmar & Cingel, 2014; Korat & Or, 2010). Conversely, children initiate more communication during e-book reading (Korat & Or, 2010). Additionally, parents' verbal communication focuses on different aspects of story reading when reading with their child in different modalities. Krcmar and Cingel (2014), in a study of iPad and paper book reading found that parents talked more about book format and environmental factors during e-book reading, while they asked more questions and provided more evaluative comments during paper book reading. Parents' communication during e-book reading, which focused more on extraneous information, distracted pre-school children from the task of reading and when tested following book reading, children's performance on measures of comprehension were negatively impacted. It has been suggested that the overall quality of adult-child interaction during paper book reading is superior to e-book reading, as parents focus more attention on dialogic and story content questions and interactions rather than behavioural comments (Parish-Morris, Mahajan, Hirsh-Pasek, Golinkoff & Collins, 2013). Recently, Troseth and colleagues (Troseth, Russo & Strouse, 2016; Strouse, O'Doherty & Troseth, 2013) have proposed that with support and education, parents may learn to provide more

"content-rich" interaction during e-book reading and assist to reverse some of the trends in adult-child interactions observed previously.

The impact of parent-child interaction during e-reading on learning may be moderated by factors such as age and level of literacy. Older children generally rely less on adults during parent led reading and may be more successful reading independently, while 2- to 3-year old children benefit more from adult interaction (Mol et al., 2008). Further, previous research suggests that kindergarten children who have already acquired basic skills through experience with traditional stories learn equally as well from adult-led stories as from independent e-book interactions (de Jong & Bus, 2004). This suggests that once children have acquired basic literacy skills, they may be equipped to read independently using e-books; however, younger children continue to receive significant benefit from parent-child interaction during reading.

In review, literature to date suggests that parent-child interaction during storybook reading plays an important role in assisting children's literacy skill development and indicates that young children should read e-books with the support of an adult for optimal learning. It is notable that when instructed to read to their child as they typically would at home, parents demonstrate decreased frequency and quality of interaction during e-book reading. However, interventions such as dialogic reading are compatible with e-book reading and may help to facilitate learning and interaction during e-reading. Most research to date has focused on verbal communication between parent and child during book reading, leaving much unknown about other aspects of adult-child interaction during e-book reading (e.g. shared visual attention). Further, research using experimental

methodologies is required to enrich our current understanding of adult-child communication during e-book reading.

Current Study

The current study was designed to address several unanswered questions regarding the suitability of e-books for preschool children. The aim of the research was to provide baseline data from an exploratory study in which 3-, 4- and 5- year-olds' recall of story content, attention deployment and engagement with the story were compared directly as they listened to equivalent readings from an e-book and from a paper book. Children's story comprehension was measured to examine children's learning from each book modality. Story comprehension is associated with pre-literacy development and plays an important role in learning to read. Previous literature has raised the concern that if interactive features are a distraction during reading, they will interfere with learning and retention of story content. Story comprehension was measured by asking children questions regarding the story following each reading including both fact retrieval as well as questions that required children to make inferences about the story. The answers to inference questions are more challenging and reflect story comprehension more generally (Grimshaw, Dungworth, McKnight, & Morris, 2007).

Attention deployment was measured in order to assess children's ability to sustain attention during e-book reading. One consequence of preschool children's immature executive functioning is that they have difficulty controlling their attention in the presence of distractions and in sustaining their attention to complete a task or activity (Colombo & Cheatham, 2006; Garon et al, 2008). E-books contain interactive features and activities, which can be distracting, yet may also call attention to important story

information and enhance recall. By examining where children directed their visual attention (to the book, researcher or off-task), the current study aimed to clarify this important research question. Additionally, visual attention provides rich information regarding children's engagement with each story type and adult-child interaction during book reading, as children may direct their gaze to adults during interaction and may engage in joint attention with the adult. To control for variation in the amount and type of adult-child interaction that occurred during book reading, adult scaffolding was kept to a minimum. The adult kept the child on-task and responded to comments and questions but did not initiate communication in either reading condition.

Children's engagement and communication was also examined during book reading. Children's engagement and interest in reading is associated with numerous positive outcomes and is not well understood among preschool children. Children's engagement was measured by independent observations of children's behaviour and utterances during book reading (see measure developed by Moody et al, 2010), children's use of interactive features during e-book reading, children's self-reported preference for the e-book or paper book and children's visual attention on and off task. Taken together, these measures provided convergent information regarding children's engagement with each reading modality. In addition to measuring children's engagement, children's spontaneous communication was examined to determine the types of communication children initiated during each book reading. Using a coding system developed by Moody and colleagues (2010), children's communication was classified into five different categories and examined for differences in content during e-book and paper book reading.

Based on the research literature on attention and children's ability to learn from e-books, it was hypothesized that:

- H1: Due to immaturity in executive functioning, younger children would have more difficulty navigating the interactive features and story content of e-books and thus would have difficulty recalling story content from e-books and benefit most from traditional paper books.
- H2: Conversely, it was hypothesized that older children, with more advanced executive attention skills, would successfully utilize the interactive features of e-books and recall more story content from e-books than from traditional paper storybooks. It was therefore predicted that 3-year-olds would correctly answer fewer story comprehension questions; recall fewer numbers during the digit span task and make more errors on the Day-Night task (measure of executive function) than the 4- and 5-year-old children.
- H3: Regarding visual attention, it was hypothesized that, similarly to predictions regarding story comprehension, differences in developing executive function would impact upon children's visual attention. Specifically, it was hypothesized that younger children would spend more time looking off-task than older children. Additionally, it was hypothesized that the interactive features and novel modality of e-book reading would impact upon children's visual attention with children devoting more visual attention to e-book reading compared to paper book reading.

- H4: Regarding engagement and communication, it was hypothesized that children would demonstrate increased engagement during e-book reading. Previous research suggests that children have a preference for e-books and demonstrate increased engagement behaviour during book reading in that modality. It was anticipated that more child-initiated communication would occur during paper book reading because the adult was reading aloud which in turn, would provide more opportunity for interaction.

The results of the current study are important for informing parents and educators about preschool children's ability to learn from e-books. There is currently no consensus in the literature about the educational value of e-books for pre-kindergarten aged children. While many educators and parents are purchasing electronic books and incorporating this type of screen media into their educational curriculums, little scientific literature has carefully examined learning in younger age groups. The study contributes to the literature on the role of attention in early learning and determines whether preschool children can learn from e-books that place additional demands on their executive functioning. By examining a broad range of e-book reading outcomes including story comprehension, engagement, communication, attention and expressive vocabulary, the current study was designed to provide practical advice to parents and educators regarding e-reading and provide a description of e-reading among a young age group.

Method

Participants

In order to participate in the study, children were required to be between the ages of 3 years 0 months and 5 years 11 months at the time of testing and able to speak and

understand English. Participants were recruited from four day-care centres in St. John's, Newfoundland and surrounding area as well as by word-of-mouth. The day-care centres included: one centre associated with a university, one centre associated with a technical college and two independently owned centres. Day-cares were matched based on socio-economic status of families serviced by each centre in order to ensure consistency in the samples recruited from each centre. The sample recruited consisted of families with high levels of parental education from middle-class residential areas. Eighty-four percent of parents who completed demographic data indicated that they had completed a university degree. In addition to recruiting from day-cares, several participants were recruited by word of mouth (the researcher was contacted by parents of children who had heard about the research study through friends and were interested in having their children participate).

Two hundred eighteen consent forms were distributed to parents by day-care staff and 92 parents returned signed consent forms. Additionally, 5 consent forms were obtained from word-of-mouth recruitment. Therefore, overall 97 consent forms were collected and a total of 87 3- to 5-year-olds provided assent (see procedure). Six participants were excluded from the sample due to an inability to sustain attention for the duration of the experimental procedure (e.g. moving from desk to explore testing room despite prompts from the researcher) or hesitancy to participate in the study and two were excluded due to technical difficulties. Therefore, 79 participants were included in the final sample, including 20 3-year-olds, 38 4-year-olds and 21 5-year-olds. The sample included 32 boys and 47 girls from families living in middle class neighbourhoods and were predominantly of Caucasian descent.

Ethics Approval

Ethics approval for the current study was obtained from the Memorial University ICEHR (reference number 20130147-RF).

Equipment

An Apple iPad 3 was used to deliver the e-books. The iPad 3 is commercially available and has a 9.7" touch screen. The e-books used in the current study were designed specifically for use on an Apple iPad and are navigated using the touch screen. A 13-inch MacBook Pro computer was used to present testing materials for the standardized assessment of receptive vocabulary. A Panasonic HC-V700M digital video camera was used to record all sessions.

Materials

Books. A variety of factors were considered when selecting the books to be used in the current study including the availability and similarity of electronic and paper formats, story length, reading level, electronic interactive features and overall quality. The two books selected for use in the current study were *Leo the Lightning Bug* (2001) and *A Frog Thing* (2006) by Eric Drachman. A third book (Ellison the Elephant, by Eric Drachman) was also available for children who were already familiar with one of the two experimental books; however, no children in the current study indicated that they had previously read the books selected.

Leo the Lightning Bug and *A Frog Thing* were selected because both books are available commercially in e-book and paper formats with each format containing the same illustrations and text. Additionally, both books were written by the same author and had a similar writing style and type of illustration. The books selected were written for

children ages 3-5 years and are therefore at an appropriate reading level for the participants in the current study. Both electronic versions of the books had the same types of interactive features including sound effects that could be activated by touching the illustrations and word pronunciations that were activated by touching the text. Movement within each page and between pages was activated by swiping the bottom of the screen. Length, word complexity and story comprehensibility were also compared between the two books. In order to ensure that both books required the same amount of time to read (approximately 10 minutes), the *Leo the Lightning Bug* book was not read in its entirety in either the e-book or paper formats and instead was stopped at a natural break on the tenth page.

Parent questionnaires. Following their child's participation in the study, parents were sent two questionnaires to complete and return to their child's daycare. The questionnaires included a parent survey developed by the researchers to collect demographic information and gather information about children's exposure to e-books and paper books at home (see Appendix C) and a standardized assessment tool used to examine executive function in pre-school children (Behaviour Rating of Executive Function: Pre-school Version, see Appendix F).

Tests

Text recognition. Text recognition is an important component of emergent literacy and refers to the child's understanding of the words on the page as a representation of the story (Shamir & Korat, 2007). Text recognition is facilitated in well designed e-books through animations that highlight the text as the narrator reads aloud (Shamir & Korat, 2007). The narration draws the child's attention to the written text and

facilitates the child's understanding of the text as a representation of the story. This early skill is foundational to children beginning to decode words and sentences. In the current study, text recognition was measured by asking the children to point to the words on the page following each story reading.

Peabody Picture Vocabulary Test. The PPVT-4 is an individually administered measure of receptive vocabulary for individuals aged 2 to 90 years (Dunn & Dunn, 2007). It is widely used in clinical, educational and research settings and has been standardized on a large sample of Canadians. The PPVT takes 10-15 minutes to administer and consists of a series of questions that require the participant to select which one of four pictures matches an orally presented vocabulary word (e.g. "Point to cat"). Standard administration procedures outlined in the PPVT-4 Administration Manual were followed (Dunn & Dunn 2007, see Appendix B). The starting point for administration is determined based on the examinee's chronological age and questions are administered until the examinee responds incorrectly to eight questions in sequence. The PPVT was utilized to measure the general language abilities of children in the current sample, given that receptive language skills play an important role in children's ability to understand storybooks. The PPVT provides important information regarding the language skills of the sample in comparison to a representative sample of Canadian children, and can inform the generalizability of the results as well as description of the current sample. The PPVT-4 has strong psychometric properties, including internal consistency reliability (M = .94), test-retest reliability (M = .93) and alternate form reliability (M = .89) (see Dunn & Dunn, 2007). Regarding validity, the PPVT-4 correlates with the EVT-2 (r = .82), CELF-4 (receptive language r = .67) and PPVT-III (r = .84).

Day-Night Task. The Day-Night Task is a measure of executive function designed for children aged 3 to 7 years (Gerstadt, Hong, & Diamond, 1994). The Day-Night Task is intended to assess response inhibition, or the ability to suppress a dominant response, in a manner similar to the Stroop Task paradigm, commonly used with adults. The Day-Night Task does not require literacy skills, making it a preferable measure of interference control for young children. Preliminary studies suggest that the Day-Night task possesses adequate internal reliability (Kuder-Richardson coefficient= 0.89 in a study by Rhoades, Greenberg & Domitrovich, 2009) and test-retest reliability (r = 0.84, Thorell & Wahlstedt, 2006). Similar to the Stroop task, which requires participants to name colours that are in conflict with the presented text, the Day-Night Task requires that the participant say a word that conflicts with the picture presented. The task consists of a series of 20 cards, 10 with pictures of a day scene (sun and sky) and 10 pictures of a night scene (moon and stars). The child is asked to respond "day" when presented a picture depicting night and "night" when presented a picture depicting day. Each child is presented with a practice set of four cards until they achieve 100% accuracy over 4 trials. Following the practice, they are shown a set of 16 cards and asked to follow the same rules as during the practice without the assistance of feedback. If a child makes four consecutive errors, he or she is reminded of the rules of the Day-Night Task. Children's performance is examined for accuracy (or number of correct responses to the 16 cards).

Digit Span Task. A forward and backward digit-span task was used as a measure of the working memory component of executive function (adapted from Kaufman & Kaufman, 2004; Mahone & Schneider, 2012). A review by Garon and colleagues (2008) suggests that the Digit Span task is an effective method of assessing simple working

memory in children ages 3 and older. The task requires the child to listen and recall sequences of numbers, beginning with two numbers and increasing to a sequence of five numbers. The experimenter reads the numbers at a pace of one number per second from a list of standard numbers administered to all participants in the same order. The experimenter notes the child's response and does not correct the child if they provide an incorrect response. If a child incorrectly recalls two sequences in a row the task is discontinued. The backward digit span task follows the same procedure as the forward digit span; however, the child is asked to repeat the numbers in backwards order. Once the child recalls the number sequence incorrectly twice in a row, the test is discontinued. Previous literature suggest that digit span tasks have strong psychometric properties when utilized to assess short-term and working memory in preschool children (test-retest reliability= $r = 0.70$, $p = <.01$ see Müller, Kerns & Konkin, 2012).

Behaviour Rating of Executive Function: Pre-school Version (BRIEF-P).

The Behaviour Rating of Executive Function: Pre-school Version is a standardized questionnaire completed by parents and designed to assess executive function in pre-school children (Gioia, Espy & Isquith, 2003). The questionnaire consists of 63 questions that assess five domains of executive function: inhibition, shifting, emotion control, working memory and planning/organizing as well as an overall global measure of executive function. Questions include a statement (e.g. Becomes upset too easily) and require the parent to indicate the extent to which each behaviour has been a problem over the past six months (never, sometimes, often). Based on responses provided, a score is calculated for each of the 5 domains as well as an overall score, with scores higher than 65 indicating clinically significant impairment. Gioia and colleagues (2003) report that

the BRIEF-P has good internal consistency (0.80 to 0.97) and test-retest reliability (0.65 to 0.94). Psychometric properties of the BRIEF-P have also been examined in a sample of Canadian pre-schoolers and results suggest that the BRIEF-P demonstrates good internal consistency (as evidenced by internal consistency scores of greater than 0.80 on all clinical scales) and low to moderate convergent validity, as evidenced by correlations varying from 0.15 to 0.81 on clinical scales of the BRIEF-P and subscales of the CBCL (Duku & Vaillancourt, 2014). The BRIEF-P was used in the current study in order to complement the assessment of executive function in the current sample using both parent report as well as testing conducted with participants.

Procedure

The study was conducted at local daycare centres in a quiet room dedicated for research purposes, or in an empty classroom. Each room contained a desk and two chairs that were an appropriate size for a pre-school child. The researcher and child sat side-by-side in order to facilitate shared book reading. A video camera was placed on a tripod in a location that minimized distraction while allowing video recording of the child. Each session was video recorded during e-book and storybook reading in order to facilitate coding and review reading sessions. Video was coded by a trained research assistant who was naïve to the study hypotheses.

Staff at each daycare centre were asked to provide parents of 3- to 5-year-old children with an information package including a promotional brochure, a letter outlining the study and a consent form (see Appendix A). The researcher visited each daycare centre one week after the consent forms had been distributed to parents to collect completed informed consent forms and begin testing. Children participated in testing

during a single one-on-one session with the researcher or a research assistant, who was also female. Sessions were typically twenty minutes in duration and were designed to be engaging and interactive for the child, with ample opportunity for breaks throughout each session. Each eligible child was invited by his/her daycare teacher to join the researcher for some activities. If the child was reluctant, he/she did not participate in the study and remained in the classroom. Assent to participate in the study was assumed from each child's willingness to join the researcher and engage in the activities. If a child indicated an interest in returning to the classroom at any time, testing was immediately discontinued and he or she was brought back to the classroom. If a child was unable to complete all of the experimental procedure in one session due to fatigue or lack of interest, the researcher invited the child to a second testing session approximately one week after their initial participation.

At the beginning of each session the researcher spent several minutes developing rapport with the child by discussing their pets, siblings or items of interest. The child was then informed about the study procedure in age-appropriate language. Specifically, they were told that they would have the opportunity to read some stories and play a game together with the experimenter. Following familiarization with the researcher and the study procedure, children began testing with the book reading. Each child was read two books: one by the researcher and one by a narrator on the e-book software. The order of book reading was counterbalanced based upon both book formant (e-book and paper book) and story content (*Leo the Lightning Bug* or *A Frog Thing*). Each story took 5-10 minutes to read depending on the story format and child's engagement in the story.

Electronic story formats generally took longer to read due to the child's use of interactive features and more frequent page turns.

E-book reading. During e-book reading, each child was presented with an electronic version of either *Leo the Lightning Bug* or *A Frog Thing*, depending on their counterbalanced condition. The child was introduced to the story on an Apple iPad by the researcher and was asked to listen carefully to the story. The researcher introduced the child to the main character of each story by asking, "Have you ever seen a frog before?" or "Have you ever heard of a lightning bug?" as appropriate to each story. The story was presented using the "read to me" e-book feature, which included pre-recorded narration of the story text and highlighted each word as the narrator read aloud. The "read to me" feature allowed the child to view the pages at their own pace by providing them the option to select when they would like to turn the page. Following the first page of the e-book, each child was given instructions on how to use the iPad touch screen to turn the page and was invited to turn the pages themselves. If the child was hesitant or did not want to turn the pages themselves, the researcher would assume the responsibility of page turning. On the occasion that the child incorrectly used the touch screen and turned the page backward, the researcher would correct the child by instructing him/her on the correct direction to touch the screen in order to turn the pages forward. The researcher also demonstrated how to use the interactive features including sound effects and repetition of printed words. The researcher demonstrated one sound effect and one word repetition hotspot on the first page of the book by pressing pictures and words on the touch screen and encouraged the child to try these features him/herself. Following instructions provided on the first page, the researcher watched the e-book with the child

while allowing the child to interact with the e-book at his/her leisure. The researcher did not engage the child in discussion during e-book reading; however, if the child had any questions or initiated communication the researcher would respond as appropriate. At the end of the e-book the researcher asked the child to point to the where the words were located on a page in order to assess the child's text recognition, which is a component of emergent literacy. The researcher then asked the child nine comprehension questions about the story details (see Appendix D). If the child was unable to provide an answer to the question or responded incorrectly, he/she was provided with 4 response options including a "don't know" choice), which were read aloud by the researcher.

Paper storybook reading. Storybook reading with the child was conducted in a similar manner as the e-book reading except for the change in the format of the book. The researcher was seated beside the child and read the storybook aloud to the child. The researcher read at a slow pace and allowed the child the opportunity to examine the story illustrations. The researcher invited the child to turn the pages if he/she desired. In order to maintain consistency with the e-book reading, the researcher did not engage the child in conversation but answered any questions that the child asked. At the end of the story, the researcher asked the child to point to the location of the words on the page to assess the text recognition component of emergent literacy and asked the child nine questions about the story using the same procedure as that used for the e-book.

Following story reading, each child completed a measure of receptive vocabulary (Peabody Picture Vocabulary Test-4) as well as two brief measures of executive functioning (the Day-Night Task and the Digit Span test). The PPVT-4 was administered using visual stimuli on a laptop computer and standard administration procedures outlined

by Dunn and Dunn (2007) were followed (see Appendix B). Children were presented with four pictures and asked to point to one based on instructions presented verbally. Following the PPVT-4, the Day Night Task was administered using a set of 20 cards following standard administration. The task began with four trial presentations where the child was taught to say "day" when shown a picture of "night" and "night" when they see "day" and included administration of a set of 20 cards. Finally, the Digit Span test was administered. Children were asked to remember and repeat increasing sequences of numbers in both forward and backwards orders.

After the child completed all of the activities he/she was thanked for his/her time and hard work. A certificate of appreciation and parent questionnaires were then mailed to the child's home address or distributed by his/her daycare centre. Approximately three weeks after the questionnaires were distributed, a reminder letter and second copy of the questionnaires were distributed to those parents who had not returned the materials.

Results

The results of parent questionnaire data are presented in the section below. Further, the results are presented in three sections: 1) story comprehension, 2) visual attention, and 3) engagement. Each section begins with an overview of data coding and analysis, review of descriptive data followed by a description of relevant findings. A series of independent sample t-tests on the data collected by each of the two experimenters and on the length of their readings did not reveal any significant differences between them: $t(78)$ values ranged from .13 to .98, all ps > .05. There was a significant difference in the total amount of time it took to read the e-book (M = 11.6 min, SE = .40) and the paper book (M = 5.26 min, SE = .13), $t(78) = 12.42$, $p < .001$, $d = 1.73$.

Questionnaire Data: Sample Characteristics. Overall, parents in the current sample reported that they have a large collection of paper books for children in their homes that they use often to read to their children. In fact, all parents surveyed indicated that they owned paper books for their children at home and 69% of parents indicated that they owned more than 60 paper books for their child. Rates of e-book use were much lower in the current sample. Fifty-eight percent of parents reported that they do not own any e-books for children and 41% percent indicated that they own 1-20 e-books. Given that most parents reported owning more paper books than e-books for children, it is not surprising that they also reported spending significantly more time reading to their children with paper books than e-books $t(54) = -14.0$, $p < .001$. Overall, parents reported spending an average of 25 minutes each day reading books with their child (SD = 12.9).

Story Comprehension

Overview of the analyses. A central research question was to compare children's story comprehension during e-book and paper book reading. This question was addressed by conducting a series of repeated measures ANOVAs using age as a between-subjects factor and type of book as a within-subject factor. Sex and order of book presentation were included in preliminary analyses and did not reveal significant main effects or interactions, therefore, data were collapsed across these variables. The dependent measures were children's overall performance on the story comprehension questions. Children's story comprehension was measured in several different ways: 1) a strict measure of story recall was the total number of correct answers recalled by the child without using recognition prompts, 2) a lenient measure of recall was calculated by adding the number of correct answers recalled and the number correctly recognized when

the child was provided with four possible options, 3) a measure of children's performance when questions were grouped by fact and inference questions. While both fact and inference questions provide a measure of children's story comprehension, inference questions provide a more robust measure, as they required a more nuanced understand of story content (e.g. How did the lightning bug feel when his friends laughed?).

Descriptive data. Children's mean scores on story comprehension questions (out of a total of 9 questions) are presented in Table 1. On average, when the lenient criterion was used, children answered two more questions correctly compared to when the strict criterion was used.

Table 1

Means and standard errors of the recall of story detail by strict and lenient criteria in electronic and paper storybooks by age.

Age	Format	Correct Recall Strict criterion	Correct Recall Lenient criterion
3 years	Electronic	3.10 (.43)	5.80 (.37)
	Paper	3.45 (.45)	5.65 (.38)
4 years	Electronic	5.55 (.33)	7.38 (.28)
	Paper	5.37(.35)	7.41 (.29)
5 years	Electronic	6.86 (.43)	8.43 (.37)
	Paper	6.62 (.47)	8.43 (.38)
Overall	Electronic	5.28 (.23)	7.26 (.20)
	Paper	5.21 (.25)	7.18 (.21)

Recall of story content: strict criterion. A repeated measures ANOVA confirmed that the effect of type of book on children's recall of story content was not significant, $F(1, 76) = 0.01$, $p = .90$, partial $\eta^2 = .00$. This suggested that children recalled information about the story content equally from both e-books and paper books. As expected, there was a significant main effect of age on children's ability to recall story content, $F(2, 76) = 18.11$, $p = <.001$, partial $\eta^2 = .32$. Follow up tests using pairwise comparisons confirmed that 5-year-olds were able to answer significantly more questions

correctly (M = 6.74, SD = 1.71) than 4-year-olds (M = 5.46, SD = 1.98) and 3-year-olds (M = 3.38, SD = 2.35). Four-year-olds were able to answer significantly more questions than 3-year-olds. There was no significant interaction between age and type of book, $F(2,76) = 0.80$, $p = .45$, partial $\eta^2 = .02$.

Recall of story content: lenient criterion. Results revealed a similar pattern of findings as with the strict criterion; children's ability to recall and/or recognize correct answers regarding story content was not affected by the type of book. There was not a significant main effect of type of book on children's recall and recognition of story content, $F(1, 76) = 0.24$, $p = .63$, partial $\eta^2 = .003$. There was a significant main effect of age on children's ability to recall and recognize story content, $F(2, 76) = 16.07$, $p = <.001$, partial $\eta^2 = .30$. Pairwise comparisons suggest that 5-year-olds were able to recall and recognize significantly more questions correctly (M = 8.33, SD = 1.85) than 4-year-olds (M = 7.40, SD = 1.46) and 3-year-olds (M = 5.72, SD = 1.85), and 4-year-olds were able to recall and recognize significantly more questions than 3-year-olds. There was no significant interaction between age and type of book, $F(2,76) = 0.18$, $p = .84$, partial $\eta^2 = .01$. These findings suggest that when a more lenient criterion is used to measure children's memory of story content, children continue to remember story content equally well during e-book and paper book reading, with older children recalling and recognizing more story content correctly than younger children regardless of book format.

Types of story content questions: fact and inference. Each set of the nine story content questions administered following story reading consisted of 5 fact questions (e.g., "What was the lightning bug's name?") and 4 inference questions (e.g., "How did the lightning bug feel?"). Given that there were an unequal number of fact and inference

questions, proportions were calculated on the number of correct fact and inference questions for each participant using the strict criterion. ANOVAs were conducted using these proportions to examine whether children's ability to correctly answer questions varied based on the type of question asked and book format.

Consistent with the analyses conducted using the strict (and also lenient) criteria for story comprehension, there was no main effect of type of book on children's correct recall of fact questions or inference questions, $F(1, 77) = 0.32$, $p = .57$, partial $\eta^2 = .004$: $F(1, 77) = 0.60$, $p = .44$, partial $\eta^2 = .008$, respectively. There was a significant main effect of age on children's correct recall of fact questions, $F(2, 77) = 7.16$, $p = <.001$, partial $\eta^2 = .16$ and inference questions $F(2,77) = 23.58$, $p = <.001$, partial $\eta^2 = .38$. Pairwise comparisons revealed that 3-year-olds answered significantly fewer fact questions than did 4- and 5-year-olds ($M = 2.05$, $SD = .24$, $M = 2.92$, $SD = .18$, $M = 3.25$, $SD = .23$) while there was no difference between 4- and 5-year-olds. Regarding inference questions, 3- and 4-year-olds answered significantly fewer questions correctly than 5-year-olds ($M = 1.31$, $SD = .22$, $M = 2.60$, $SD = .17$, $M = 3.43$, $SD = .22$ respectively). There was no interaction between type of book and age on children's correct recall of fact questions or inference questions, $F(2, 77) = 0.86$, $p = .43$, partial $\eta^2 = .02$ and $F(2, 77) = 0.72$, $p = .49$, partial $\eta^2 = .02$, respectively.

In summary, these data indicate that regardless of the type of book, younger children answered significantly fewer inference questions correctly than did older children. This is consistent with previous literature, which suggested that inference questions are more difficult for young children to answer than fact retrieval questions (Grimshaw et al., 2007).

Receptive vocabulary. The Peabody Picture Vocabulary Test (PPVT-4) was used to examine children's receptive vocabulary, as basic receptive vocabulary skills impact children's story comprehension. The average standard score on the PPVT-4 in the current sample was 112.74 (*SD* = 12.77), which is above the population mean (*M* = 100, *SD* = 15). This suggested that children in the current sample had acquired important receptive vocabulary skills necessary for understanding storybooks. Three-year-olds had an average standard score of *M* = 115.19, *SD* = 10.99, 4-year-olds *M* = 115.11, *SD* = 11.65 and 5-year-olds *M* = 106.90, *SD* = 14.40. A one-way ANOVA of the growth score value (GSV) data recommended for age comparisons, indicated a significant increase in receptive vocabulary size across each age group: $F(2, 71) = 13.13$, $p < .001$. Moreover, scores were positively correlated with story recall (strict criterion) in both electronic and paper formats at all ages. Children with larger receptive vocabularies were able to recall more information from both stories.

Executive Function and Story Comprehension

Overview of the analyses. Given that previous research has suggested that electronic books may present a distraction and place additional demands on young children's executive function, a variety of components of executive function were measured and examined in the current analyses. The BRIEF-P parent questionnaire was used to measure executive function across all domains, the Digit Span Task measured working memory and the Day-Night Task measured response inhibition. The sections below provide descriptive statistics for each of the executive function measures followed by a summary of findings from the data analyses. Regarding data analyses, a series of

three Pearson's r correlations were conducted on measures of executive function and story recall for each age group (see Table 2).

Table 2

Correlations between measures of executive function and story recall by age.

Age	Format	PPVT	Day/Night Task	Forward Digit Span	Backward Digit Span	BRIEF-P
3 years	Electronic	.56*	.37	.03	--	-.41
	Paper	.50*	.79**	.49*	--	-.45
4 years	Electronic	.67**	.45**	.49**	.36*	-.04
	Paper	.52**	.28*	.44**	.32*	-.21
5 years	Electronic	.53**	.76**	.67**	.40*	.13
	Paper	.61**	.85**	.67**	.67**	.46*

Note: *p<.05; **p>.01 (2-tailed)

Parent's rating of their child's executive function using BRIEF-P questionnaire. Fifty-seven parents, comprising 71% of sample, completed and returned the BRIEF-P questionnaire. There were no observed differences in sex or age demographics for the sample of children whose parents returned the questionnaires when compared to the overall sample. This suggests that information gathered from parent questionnaires is representative of the current sample. The sample of children whose parents returned questionnaires included 26 males and 31 females, 14 3-year-olds, 28 4-year-olds and 15 5-year-olds.

Parents' responses on the BRIEF-P suggest that children in the sample have developmentally appropriate executive function skills. On average, children's scores on the five components of the BRIEF-P (inhibition, shifting, emotion control, working memory and planning/organizing) were below 65, which suggested no clinically significant concerns regarding executive function (see Table 3).

Table 3

Mean t-scores on each index of the BRIEF-P and overall Global Executive Composite (GEC) as a function of age.

Age	Inhibition	Shifting	Emotion Control	Working Memory	Planning/ Organizing	GEC
3 years	49.2 (2.45)	43.33 (1.22)	43.73 (1.69)	46.07 (2.48)	46.20 (2.67)	45.21 (2.27)
4 years	47.21 (1.59)	47.68 (1.49)	49.36 (1.67)	46.43 (1.41)	43.82 (1.61)	45.86 (1.61)
5 years	45.27 (1.65)	46.27 (2.17)	48.33 (2.77)	44.87 (1.57)	43.73 (1.46)	44.4 (1.46)
Overall	47.22 (1.08)	46.19 (.98)	47.64 (1.19)	45.93 (1.01)	44.41 (1.01)	45.32 (1.02)

Note. T-scores have a mean of 50 and standard error of 5. Standard errors are in parentheses.

Day-night task. The number of correct responses children provided on the day-night task (out of a total of 16 questions) was converted to a percentage of total correct responses (see Table 4). Overall, older children answered more questions correctly than

did younger children. Three-year-olds correctly answered an average of 7.94 questions (*SD* = 6.33). Four-year-olds correctly answered an average of 11.92 questions (*SD* = 4.87) and five-year-olds correctly answered an average of 12.67 questions (*SD* = 5.40). A review by Montgomery and Koeltzow (2010) suggests that typical accuracy on day-night tasks is 47% for 3-year-olds, and accuracy increases to 77% by age five. The performance of the 3-, 4- and 5-year-olds in the current study was consistent with these findings. A one-way ANOVA revealed significant differences between age groups (F (2, 76) = 4.42, p = .01), with 3-year-old answering significantly fewer questions correctly than older children. Follow up analyses using single sample t-tests suggest that 3-year-olds did not respond significantly better than chance (t = -.04, df = 17, p = .97).

Table 4

Percent of correct responses on Day-Night Task by age group.

Age	Percent correct responses Day-Night task
3	49.62%
4	74.50%
5	79.19%

Digit Span

Three-year-old children in the current sample were unable to correctly complete the backward digit span task and therefore only forward digit span scores are calculated for this age group (see Table 5). Overall, children's ability to remember and repeat

sequences of numbers increased with age. These data are consistent with forward and backward digit span data reported previously (Mahy & Moses, 2011).

Table 5

Average number of correct number of digits recalled during forward and backward digit span test by age.

Age	Average digit span forward	Average digit span backward
3 years	3.28 (.57)	N/A
4 years	3.97 (.72)	.76 (1.28)
5 years	4.33 (.66)	1.85 (1.15)

Note: Standard errors are in parentheses.

Summary. Among 4- and 5-year-olds there was a significant positive correlation between some measures of executive function and story recall including Digit Span and the Day Night task. These data suggest that, regardless of the story format, older children with stronger executive function abilities recalled more story content. Given that children recalled story information equally well from electronic and paper formats, and executive function was strongly correlated with story recall in both formats, there is no indication that the electronic story book required additional executive function skills in order to facilitate learning and story recall. Children's scores on the BRIEF-P were not significantly correlated with performance on story recall. This may be due to the inability of the BRIEF-P to distinguish differences in executive function skills between participants in the current sample. Given that the BRIEF-P is a tool used to assess

deficits in executive function, it may not have been as sensitive to detecting differences in the current sample, where no children were identified with significant deficits in executive function. Additionally, this measure relied on parent report, which can be prone to biases.

Visual attention

Data coding. Coding of visual attention was conducted using in-house software developed for the analysis (Earle, 2013). The program allowed the coder to review video in real-time and use keystrokes to identify the location of the child's visual attention (determined by direction of eye gaze). Visual attention was coded as directed toward one of three locations: 1) on-task at the book, 2) on the experimenter, or 3) off-task in some other direction. The coder reviewed the video and each time the child's gaze moved locations, the coder pressed the key corresponding to the new location. The program facilitated the coding of the duration and frequency of looks to each location by summing the total duration of time between key presses and the number of key presses. Twenty-five percent of all videos were coded by a second trained observer, who was naïve to the hypotheses of the study, to ensure reliability of coding. Based on these pairs of observer judgements on the duration of visual attention to each of the three locations, inter-observer reliability was calculated using the Kappa statistic and found to be .72 with a percentage agreement (Pearson-product-moment correlation) of 94.6. These data indicated a substantial degree of agreement between coders (Cohen, 1960).

Overview of the analyses. A second research question examined children's visual attention during e-book and paper book reading. A series of 3 (age: 3, 4, 5 year olds) x 2 (book type: e-book, paper book) repeated measures ANOVAs with age as the

between-subjects factor and type of book as the within-subjects factor were conducted. Preliminary analysis in which sex and order of book presentation were included did not reveal significant main effects or interactions, therefore, data were collapsed across these variables. Given that there was a statistically significant difference in the total duration of time spent reading the e-book and paper book (M = 11.8 minutes, M = 5.19 minutes), the proportions of total time spent looking at each book, the adult and off-task (see Table 6) were used as the dependent measure in the analyses of visual attention.

Descriptive data. Children's attention was examined by utilizing several measures of visual attention including: 1) total duration of looks, 2) frequency of looks, 3) mean duration of looks, and 4) proportion of total time spent looking. These measures of visual attention were calculated to reflect children's attention to the e-book, the paper book, the adult, and off-task. Tables 6, 7, 8, and 9 provide the descriptive statistics for these measures. Figure 1 summarizes these data. Overall, children were highly attentive during story reading but spent a greater proportion of time looking at the e-book than the paper book. Conversely, they looked more at the adult during the paper book than the e-book reading.

Table 6

Mean and standard error of total look durations (seconds) directed to electronic and paper storybooks, the adult, and off-task by age.

Age	Format	Book	Adult	Off-task
3 years	Electronic	550.62 (21.65)	28.48 (9.24)	36.85 (10.19)
	Paper	254.86 (12.73)	24.89 (8.04)	48.12 (9.88)
4 years	Electronic	696.40 (50.80)	28.55 (5.94)	29.33 (6.60)
	Paper	282.92 (6.28)	14.23 (3.25)	19.30 (4.41)
5 years	Electronic	680.35 (63.13)	18.59 (5.29)	10.92 (4.96)
	Paper	262.00 (10.38)	11.13 (3.96)	14.10 (5.52)
Overall	Electronic	656.57 (30.95)	25.87 (3.92)	26.20 (4.38)
	Paper	270.45 (5.25)	15.88 (2.75)	24.96 (3.79)

Table 7

Mean and standard error of total frequency of look durations (seconds) directed to electronic and paper storybooks, the adult, and off-task by age.

Age	Format	Book	Adult	Off-task
3 years	Electronic	20.63 (4.04)	13.79 (3.71)	9.53 (2.66)
	Paper	14.00 (1.89)	8.16 (1.77)	8.42 (1.43)
4 years	Electronic	21.23 (2.78)	13.95 (2.39)	8.20 (1.56)
	Paper	10.82 (1.22)	6.56 (1.14)	5.05 (.77)
5 years	Electronic	17.38 (3.55)	13.67 (3.34)	4.00 (1.26)
	Paper	8.76 (1.87)	6.09 (1.71)	2.67 (0.74)
Overall	Electronic	20.06 (1.91)	13.87 (1.70)	7.42 (1.07)
	Paper	11.03 (.92)	6.82 (0.83)	5.23 (0.59)

Table 8

Mean and standard error of mean look durations (seconds) directed to electronic and paper storybooks, the adult, and off-task by age.

Age	Format	Book	Adult	Off-task
3 years	Electronic	113.21 (44.66)	1.70 (.21)	3.91 (.36)
	Paper	48.59 (19.33)	.01 (.00)	5.34 (.87)
4 years	Electronic	75.96 (13.27)	2.03 (0.54)	5.61 (2.97)
	Paper	62.69 (12.51)	.07 (.06)	3.43 (.34)
5 years	Electronic	167.13 (67.03)	1.12 (.13)	2.03 (.37)
	Paper	89.45 (21.62)	.01 (.00)	7.87 (4.28)
Overall	Electronic	109.58 (21.87)	1.75 (.30)	4.61 (1.59)
	Paper	66.46 (9.65)	.04 (.03)	4.03 (.88)

Table 9

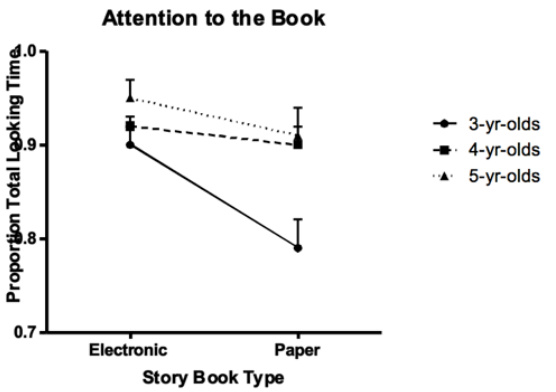
Means and standard errors of the proportion of total looking time directed to electronic and paper storybooks, the adult, and off-task by age.

Age	Format	Book	Adult	Off-task
3 years	Electronic	.90 (.02)	.04 (.01)	.06 (.01)
	Paper	.79 (.03)	.07 (.02)	.14 (.02)
4 years	Electronic	.92 (.01)	.04 (.01)	.04 (.01)
	Paper	.90 (.02)	.04 (.01)	.06 (.02)
5 years	Electronic	.95 (.02)	.03 (.01)	.02 (.01)
	Paper	.91 (.03)	.04 (.02)	.05 (.02)
Overall	Electronic	.92 (.01)	.04 (.01)	.04 (.01)
	Paper	.87 (.02)	.05 (.01)	.08 (.01)

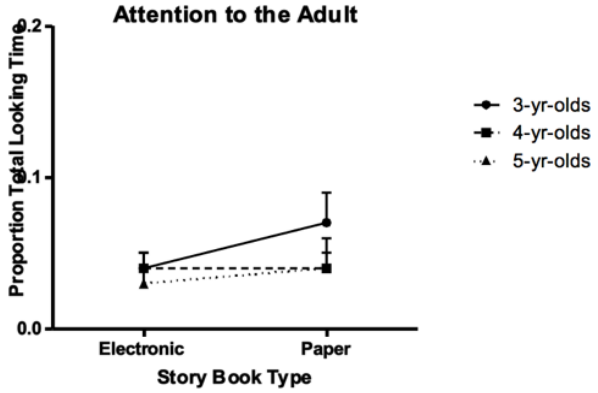
Proportion of total time spent looking at the book. Overall, children were very focused on-task when being read to in both electronic and paper book formats. Children spent an average of 92% and 87% of their time looking on-task in the e-book and paper book conditions respectively. A repeated measures ANOVA revealed significant main effects of the type of book, $F(1, 74) = 25.89$, $p < .001$, partial $\eta^2 = .26$ and age $F(2, 74) = 4.11$, $p = .02$, partial $\eta^2 = .10$, on the proportion of time children spent looking on-task. Follow up analyses using pairwise comparisons suggested that children spent a significantly greater proportion of their time looking at the e-book ($M = .92$, $SD = .09$) than the paper book ($M = .88$, $SD = .13$). Additionally, 3-year-olds spent significantly

less time looking on-task (*M* = .85, *SD* = .13) than did 4-year-olds (*M* =.91, *SD* = .08) or 5-year-olds (*M* = .93, *SD* = .09). These main effects were qualified by a significant interaction between type of book and age, $F(2, 74) = 4.91$, $p = .01$, partial $\eta^2 = .11$ (see Figure 1a). Follow-up analyses of this interaction with paired sample t-tests suggested that 3- and 5-year-olds spent significantly more time with their visual attention directed on task during the e-book story reading than the paper book story reading, $t = 3.47$, $df = 17$, $p = .003$ and $t = 2.22$, $df = 20$, $p = .003$. Although 4-year-olds also looked more at the e-book than the paper book, the difference only approached significance, $t = 1.82$, $df = 37$, $p = .08$. These results suggest that although children spent the majority of their time focused on-task while reading both book formats, they had a tendency to spend more time focused on-task during e-book reading. The observed difference in visual attention was more marked for 3-year-olds, who spent 90% of their time looking at the e-book and 79% looking at the paper book.

(a)



(b)



(c)

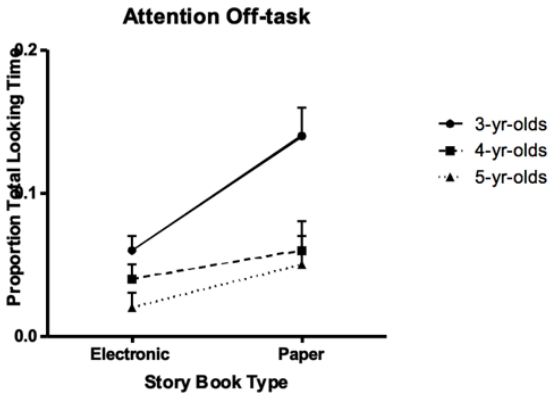


Figure 1. Proportion of time spent looking to the (a) book, (b) adult and (c) off-task as a function of type of book (e-book or paper book) and age (3, 4, 5 year olds).

Proportion of total time spent looking at the adult. The amount of time children spent looking at the adult (researcher) was relatively low in all age and book groups (see Table 9). Data analysis revealed a significant main effect of the type of book on the proportion of time spent looking at the adult, $F(1, 74) = 4.20$, $p = .04$, partial $\eta^2 = .05$. Pairwise comparisons suggest that children spent a significantly greater proportion of their time looking at the adult when reading the paper book ($M = .05$, $SD = .07$) compared to the e-book ($M = .04$, $SD = .05$). There was no main effect of age, $F(2, 74) = .94$, $p = .40$, partial $\eta^2 = .02$, or interaction between book type and age, $F(2, 74) = .92$, $p = .40$, partial $\eta^2 = .02$. Taken together, these results suggest that although children directed very little visual attention to the adult when reading in both book formats, there was a small, statistically significant difference in children's time spent looking at the adult, whereby they looked at the adult more when reading the paper book compared to the e-book (Figure 1b).

Proportion of total time spent looking off-task. Overall, the amount of time children spent looking off-task was low in all conditions (see Table 9). A repeated measures ANOVA revealed significant main effects of the type of book, $F(1, 74) = 22.86$, $p = .001$, partial $\eta^2 = .24$, and age, $F(2, 74) = 4.95$, $p = .01$, partial $\eta^2 = .12$, on the proportion of time children spent looking off-task. Pairwise comparisons suggest that children directed more attention off-task when reading the paper book ($M = .07$, $SD = .10$) compared to the e-book ($M = .04$, $SD = .05$). Additionally, younger children spent significantly more time looking off-task than did the older children ($M = .05$, $SD = .07$ and $M = .14$, $SD = .13$ for 3-year-olds compared to $M = .02$, $SD = .04$ and $M = .05$, $SD = .09$ for 5-year-olds). These main effects were qualified by a significant interaction

between book type and age, $F(2, 74) = 4.22$, $p = .02$, partial $\eta^2 = .10$ (see Figure 1c). Follow up analyses of this interaction using paired sample t-tests suggested that 3 and 4-year-olds spent significantly more time with their visual attention directed off task during paper book reading compared to e-book reading, $t = -2.92$, $df = 17$, $p = .01$ and $t = -2.34$, $df = 37$, $p = .02$, while 5-year-olds were equally distracted off-task during e-book and paper book reading, $t = -1.97$, $df = 20$, $p = .06$. Overall these results suggest that, although the amount of time spent looking off-task was low among all participants, the younger children spent significantly more time looking off-task during paper book reading.

In summary, analyses of visual attention during e-book and paper book reading indicated that children spent the majority of their time looking on-task regardless of book format, although they spent more time on-task during e-book reading. Older children were able to maintain more of their attention on-task compared to younger children. During the relatively small amount of time that children directed their attention off-task from the book, they spent more time looking at the adult and off-task during paper book reading.

Engagement

Engagement was measured using self-report and observational data (coded by trained observers). Additionally, visual attention data described above provided information regarding children's engagement. The sections below describe each measure of engagement as well as results of data analysis relevant to each measure.

Self report. Self-report data regarding children's engagement with each story format was gathered by asking each child about their preferences following book reading

(Baroody & Diamond, 2013). Children were asked whether they preferred the e-book or paper book. Results suggest that regardless of the story being read, children indicated a preference for e-books (68% of children indicated a preference for the e-book format, while 32% endorsed either preference for the paper format or no preference). In contrast to children's preferences, when parents were asked whether they prefer e-books or paper books for young children, parents overwhelming expressed a preference for paper books. In total, 98% of parents indicated that they preferred paper books for pre-schoolers. This is consistent with parents' reports that they own more paper books and spend more time reading with paper books. Parents in the current sample provided a variety of reasons for their preference for paper books including: familiarity and comfort with using paper books, desire to limit child's screen time, opportunity for the child to develop fine motor skills during page turning and simplicity of using paper books (e.g. no batteries required). Taken together these results suggest that children may demonstrate increased engagement during e-book reading due to their preference for reading in this format, although parents overwhelmingly prefer paper books.

Observational measure of engagement: enthusiasm, persistence and compliance.

Data coding. Coding of observational data was conducted using a scoring system adapted by Skibbe, Moody, Justice and McGinty (2010) (see Appendix E). Their system was based on the Minnesota Teaching Task, an instrument developed for use in a national study of early childcare to assess behavioural and affective dimensions of parent-child interaction during free play (National Institute of Child Health and Development, see Egeland et al., 1995). This scoring system has also been adapted by Moody et al. (2010)

for use in research on parent-child dyads during e-book and paper book reading. A detailed coding scheme was obtained from Dr. Moody in order to facilitate coding. Each video was reviewed and coded on three measures of engagement: 1) enthusiasm, 2) persistence, and 3) compliance. Each of the three measures of engagement was coded on a 7-point scale, with a score of 7 indicating high levels of engagement and a score of 1 indicating low levels of engagement (see Appendix E for a detailed description of the coding system). E-book and paper book reading were coded separately; therefore, each child received a score out of 7 on the three measures of engagement for both e-book and paper book reading. Twenty-five percent of all videos were coded by a second trained observer who was naïve to the hypotheses of the study to ensure reliability of coding. Based on these pairs of observer judgements, inter-observer agreements were calculated using intra-class correlations for each of the three measures of engagement (enthusiasm, persistence, compliance) and found to be .71, .83 and .96 respectively.

Overview of the analyses. Wilcoxon matched-pairs signed-ranks tests were conducted on the measures of enthusiasm, persistence and compliance for e-books and paper books by age group (ages 3, 4 and 5).

Descriptive data. The mean scores on measures of engagement are presented in Table 10.

Table 10

Means and standard errors of scores (out of 7) on measures of engagement by age.

Age	Format	Enthusiasm	Persistence	Compliance
3 years	Electronic	4.37 (1.42)	5.26 (.99)	6.05 (1.27)
	Paper	3.84 (1.11)	4.84 (1.07)	5.84 (1.50)
4 years	Electronic	4.33 (1.38)	5.79 (.61)	6.62 (.71)
	Paper	4.02 (1.20)	5.72 (.60)	6.61 (.63)
5 years	Electronic	4.67 (1.49)	6.14 (.91)	6.57 (1.08)
	Paper	4.38 (1.28)	5.76 (.83)	6.33 (1.24)

Note: Scores are based on a Likert scale rating from 1-7, with 7 indicating high levels of enthusiasm, persistence and compliance.

Enthusiasm. Overall, children demonstrated increased enthusiasm during e-book reading ($Z = -3.00$, $p = .003$). When data were analysed based on age group, results revealed that among 3-year-olds there was no significant difference in enthusiasm during e-book and paper book reading ($Z = -1.54$, $p = .12$) (see Table 10). Among 4-year-olds, there was a significant difference in enthusiasm between e-book and paper book reading ($Z = -2.03$, $p = .04$). Four-year-old children were more enthused during e-book reading ($M = 4.33$, $SD = 1.38$) than paper book reading ($M = 4.02$, $SD = 1.20$). Among 5-year-olds there was no significant difference in enthusiasm between e-book and paper book reading *(*$Z = -1.73$, $p = .08$), although this difference suggested a trend for 5-year-olds to

have demonstrated more enthusiasm during e-book reading than paper book reading (see Table 10). These results provide some evidence that children were more enthusiastic during e-book reading compared to paper book reading.

Persistence. Overall, children demonstrated increased persistence during e-book reading (Z = -2.92, p = .003). When data were analysed based on age group, results revealed that among 3- and 4-year-old children, persistence did not differ between e-book and paper book reading (Z = -1.51, p=.13 and Z = -.83, p = .40 respectively). Among 5-year-old children there was a significant difference in persistence between the two books (Z = -2.53, p = .01). Five-year-olds were more persistent during e-book (M = 6.14, SD = 0.91) reading than paper book reading (M = 5.76, SD = 0.83). Overall, older children demonstrated increased persistence during e-book reading compared to paper book reading.

Compliance. Among all age groups (3, 4 and 5 year olds) there were no significant differences in compliance between e-book and paper book reading (Z = -.59, p = .56, Z = .00, p = 1.0 and Z = -1.29, p = .20 respectively). Children were equally compliant during paper book and e-book reading.

Interactive features. The use of interactive features was examined as a measure of children`s engagement during e-book reading. During video coding, the number of times the child touched the iPad screen to activate a hotspot was recorded. This included touching the screen to activate sound effects as well as repetition of narrated story text. Children`s use of interactive hotspots varied significantly, with children using an average of 57.15 hotspots (SD = 121.52). It is notable that there were children who did not engage with any hotspots, while others took all available opportunities to use interactive

features. The number of hotspots activated during e-book reading ranged from 0 to 628. Half of the sample used less than 10 hotspots, suggesting that many children spent very little time interacting with the e-book, while a smaller portion of the sample (15%) used more than 100 hotspots, suggesting that they spent a significant portion of their book reading time engaging with interactive features. A one-way ANOVA on a log transformation of the number of activations data indicated a significant main effect for age: $F(2, 69) = 3.44$, $p < .04$ such that the number of hotspot activations increased systematically across 3-, 4-, and 5-year age groups: *Ms* = 16.11 (*SE* = 5.29); 53.34 (*SE* = 15.98); 101.19 (*SE* = 13.76), respectively.

Communication

Data coding. Coding of children's communication was conducted based on a system adapted by Moody and colleagues (2010) from measures used in previous research on e-book reading (e.g., Fish, Shulman, Akerman & Levin, 2002). Each video was reviewed and coded on five types of verbal communication the child could initiate during story reading: 1) labelling, 2) story content, 3) external references, 4) medium-specific, and 5) miscellaneous. Labelling communication refers to comments regarding the names of characters or pictures in the book (e.g., "Who is that?"). Story content communication refers to comments regarding the story plot (e.g., "Why is he sad?"). External reference communication refers to comments that link external information to the story content (e.g., "I have a nightlight like that one"). Medium specific communication refers to comments related to the iPad or physical paper book (e.g., "How do I turn the page?"). Lastly, miscellaneous communication refers to comments made by the child that are unrelated to the story content or task (e.g., "I'm bored").

Each video was reviewed in real time and each time the child initiated verbal communication with the experimenter, the coder noted the child's comments or questions and categorized them into 1 of the 5 categories. If a child said multiple sentences regarding one concept, this was coded as one communication and placed in one category. Descriptions of each category of communication were obtained from Moody et al. (2010) and utilized to determine the classification of each utterance. Twenty-five percent of all videos were coded by a second trained observer who was naïve to the hypotheses of the study to ensure reliability of coding. Inter-observer agreements were calculated using intra-class correlations and found to be .67, .82, .62, .76, .77 for labelling, story detail, external references, medium specific references and miscellaneous references respectively, suggesting good reliability of communication coding procedures.

Overview of the analyses. A fourth question of interest concerned the way in which children's spontaneous verbal communications might differ during e-book and paper book reading. A paired-sample t-test was conducted on the total number of communications initiated. Repeated measures ANOVAs were conducted on the data to examine differences in the types of communication initiated. A series of paired sample t-tests on the number of utterances of different types of communication during the e-book and paper book sessions for the full sample was conducted.

Descriptive data. In general, children of all ages communicated very little during the storybook sessions (see Table 11), with about a quarter of them (26.9%) saying nothing at all in either of the two sessions.

Table 11

Mean (and standard error) of the communication types initiated by the children during e-book and paper book reading as a function of age.

Age	Format	Total	Label	Story content	External referent	Medium specific	Misc
3 years	Electronic	5.95 (1.6)	.47 (.17)	2.35 (.77)	.26 (.13)	1.42 (.68)	1.42 (.54)
	Paper	4.21 (1.2)	.68 (.23)	2.05 (.66)	.11 (.07)	.05 (.05)	1.32 (.52)
4 years	Electronic	5.84 (1.5)	1.16 (.41)	2.24 (.73)	.16 (.06)	.84 (.23)	.68 (.20)
	Paper	3.45 (.84)	.87 (.30)	1.61 (.41)	.13 (.05)	.16 (.11)	.48 (.20)
5 years	Electronic	5.09 (1.6)	.62 (.35)	2.19 (.79)	.05 (.04)	1.19 (.37)	1.05 (.46)
	Paper	1.86 (.62)	.14 (.10)	1.14 (.42)	.00 (.00)	.10 (.09)	.47 (.20)

Communication. There were significantly more utterances during the e-book than the paper book reading $t(77) = 3.58$, $p = .001$. However, as the duration of the two reading sessions differed (11.78 min vs. 5.19 min), the total communications data were corrected for session length by calculating the total utterances in e-book and paper book condition as a function of the total reading time for each type of book. The mean number of spontaneous utterances the children made were not significantly higher during the e-book than the paper book reading, $F(1, 74) = 0.72$, $p = .40$), $\eta^2 = .01$, and this did not vary with age, $F(2, 75) = 0.58$, $p = .56$, $\eta^2 = .01$, nor were there any interaction between age and book format, $F(2, 75) = 0.93$, $p = .40$, $\eta^2 = .02$. These findings suggested that e-

books elicited more communication due to the overall longer total duration of book reading.

Sub-types of communication during e-book and paper book reading. As the analyses of the total number of utterances corrected for differences in session length did not indicate any differences as a function of age, the analyses of the different categories of utterances were collapsed across this variable. There were significant differences in the types of communication initiated during book reading that favored the e-book only for medium specific references, $t(77) = 4.96$, $p < .001$. When the analyses were repeated on the sub-group of participants who provided utterances on both e-book and paper book sessions (n = 40) results again suggested that children made more medium specific references, $t(39) = 3.15$, $p = .003$ during the e-book than the paper book reading session. Additionally, children communicated more using labelling and discussing story content in the paper book condition, $t(39) = -2.12$, $p = .04$, $t(39) = -2.25$, $p = .03$. Collectively, results confirmed that children of all ages communicated very little during the book reading sessions. Their greater communication during the e-book was largely due to their comments about the medium (i.e., the iPad) itself. This pattern held both when the full sample was considered and also when the sub-group who made utterances on both of the sessions was considered.

Discussion

In recent years, e-books have become increasingly popular despite mixed findings in the literature regarding their suitability for young readers (Scholastic, 2013). Given the significant relationship between early exposure to storybooks and later literacy outcomes such as learning to read, the general objective of the current study was to examine the

impact of e-book and paper book reading on young children's story comprehension and engagement. Overall, the results suggested that when read with adults, well designed e-books can facilitate literacy as well as can paper books. In the following sections, results of the current study are discussed in the context of the current literature.

Story Comprehension

A central goal of the current study was to examine children's literacy skill development during electronic and paper book reading. Story comprehension was utilized as a measure of literacy development. Results of the current study suggest that preschool children's story comprehension does not differ when stories are read in electronic and paper formats. This finding was consistent across all age groups, types of comprehension questions and methods of recall, suggesting that e-books and paper books equally facilitate literacy development among pre-school children.

Situating these findings within the context of the current research provides a challenge given that to date, results of research examining story comprehension during e-book reading are mixed (see meta-analyses by Takacs, Swart & Bus, 2014, Zucker et al., 2009). Previous studies have concluded that e-books facilitate story comprehension in young readers (Doty et al., 2001), hinder story comprehension (de Jong & Bus 2002; Krcmar & Cingel, 2014) and are comparable to story comprehension using traditional books (de Jong & Bus, 2004). It has been proposed that the diversity of findings to date reflect the significant variety of e-books available and differing environments in which e-books are read. Features of the e-book and the story reading environment that have been found to impact upon story comprehension outcomes include:

1) interactive features, 2) story quality and 3) adult-child interaction. These are discussed in the sections below.

Interactive features. One body of research suggests that carefully designed interactive features that are congruent with story content facilitate children's learning by helping them to understand story content and increasing their engagement with reading, while those features that are incongruent with story content distract young readers (Moody et al, 2010, de Jong & Bus, 2004). Given these findings, the e-books utilized in the current study contained only congruent hotspots. Results of the current study indicated that when preschool children interacted with e-books with congruent hotspots, they demonstrated similar story comprehension to paper books. This suggests that the interactive features embedded in the e-book did not provide an advantage for children's story comprehension. These findings are inconsistent with the research discussed above which hypothesize that e-books with congruent hotspots may be superior to paper books for facilitating story comprehension. It is notable that children in the current study were provided the option to interact with interactive features at their leisure. Therefore, there was significant diversity in the number of hotspots children used, with some children using very few hotspots. Those children in the sample who used few hotspots would not have had the opportunity to avail of the additional benefits that have been previously associated with congruent hotspots.

The results are consistent with a second emerging area of research that indicates that the level of interactivity required from the young reader has an effect on their story comprehension. This literature makes a distinction between "multimedia" and "interactive" features (Bus, Takacs & Kegel, 2015, Takacs et al, 2014). Multimedia

features include animated pictures, sound and music that are presented automatically as the child reads along with the e-book, while interactive features include hotspots, games and dictionaries that are activated by the child as they engage with the e-book. The e-books used in the current study contained both interactive and multimedia features, requiring the child to switch between listening to story content and engaging with interactive features. A recent meta-analysis revealed a significant benefit of e-book reading on children's story comprehension among those stories that included multimedia features, while no additional benefit was found for interactive features (Takacs et al., 2014). Our findings are consistent with this literature and suggest that interactive features provide no additional benefits beyond traditional book reading. When children use interactive features, they must engage in task switching, as they direct their attention from the story to the use of interactive features, which does not enhance their story comprehension. There appears to be a trade off, whereby congruent hotspots may provide additional valuable information to the reader, however, the process of engaging with these features has deleterious effects.

Story Quality. In addition to the design of multimedia and interactive features, overall story quality has been found to play a role in early literacy development using e-books and has been associated with increased story comprehension in young children (Colombo, Landoni & Rubengni, 2014). The storybooks selected for the current study were carefully examined to ensure they were well written and engaging. Additionally, both books used in the current study were written by the same author in order to ensure similar quality. It is hypothesized that, in the context of the current study, the high quality of the stories may have facilitated learning regardless of the method of

delivery. Recently, tools have been developed to assess the quality of electronic books (Yokota & Teale, 2014). These tools have been targeted for teachers to assist with the selection of appropriate e-books and to facilitate the integration of electronic storybooks into educational settings.

Adult Interaction. While adult-child interaction during paper book reading has been found to facilitate story comprehension, in the current study this type of interaction was kept to a minimum due to the lack of evidence regarding adult-child interaction during e-book reading (Bus et al, 2015). For example, a study by Chiong et al (2012) suggested that children may be bothered by having adults interfere during their interactions with e-book reading. Therefore, given the lack of understanding regarding the potential role of specific strategies adults may utilize during e-book reading and to be consistent across both book formats, adults in the current study did not initiate interaction during either book reading. Rather, adults were present during both of the reading sessions, which allowed the child the opportunity to ask questions and interact with the adult if they needed help or information. This ensured that each condition was consistent with regard to adult interaction and that children were kept on task. A consequence of this was that the current study provides limited information regarding the efficacy of adult-child interaction during book reading, as techniques such as scaffolding and asking questions were not used. Additionally, overall, story comprehension scores were relatively low for the younger children in the current sample. It may have been that story comprehension scores would have been higher if the adult was utilizing shared reading techniques such as scaffolding, which improve children's story comprehension when reading in paper formats. In the future, it will be important to establish if techniques such

as dialogic reading are equally effective when reading with a child in electronic and paper formats.

Conclusions. Our findings are consistent with several previous studies and suggest that under certain conditions, story comprehension does not differ between electronic and paper story formats (de Jong & Bus, 2004; Grimshaw et al., 2007; Korat & Shamir, 2007). These conditions include: the use of a high quality e-book, carefully designed interactive features and adult involvement in story reading (de Jong & Bus, 2004; Korat and Shamir, 2007). An important implication of these findings is that under the conditions described above, interactive features did not impede learning and memory of storybook content. This finding has important implications for parents and educators who have raised concerns regarding e-reading. It is hypothesized that if the e-books contain only multimedia features that are compatible with the story and are read with an adult using dialogic techniques, e-books may provide additional benefits beyond paper books. This is a question for future research.

Executive Function

Among 3- and 4-year-olds there was a significant positive correlation between measures of executive function and story recall. Children in the sample demonstrated above-average executive function skills based on parental report using the BRIEF-P questionnaire. On both measures of memory (Digit Span) and response inhibition (Day-Night Task) older children demonstrated more advanced executive function abilities than did young children. As expected, older children with more advanced executive function abilities demonstrated better story comprehension than did younger children who had less developed executive function abilities.

It was hypothesized that e-books would place additional demands on young children's executive function and result in decreased story comprehension. However, this hypothesis was not supported in the current study. There was no interaction observed between children's story comprehension, executive function and story type. This suggests that preschool children can benefit from e-book reading and can possess sufficient executive function skills in order to effectively interact with e-books. It is notable that, on average, children in the current sample demonstrated above-average receptive vocabulary and executive function skills. It is possible, therefore, that electronic and paper storybooks facilitate storybook comprehension equally among young children who have prior exposure to literacy materials and strong executive function skills. Consistent with this, all but two children (one 3-year-old; one 4-year-old) showed an awareness of print and were able to point to the words that told the story in both book formats. The children's previous experience with storybooks and strong receptive vocabulary skills and executive function may have facilitated their ability to maintain focused attention during e-book reading, despite the potential distraction of interactive features. The sample in the current study did not include children with deficits in executive function; therefore, the findings of the current study cannot be generalized to these children. It is hypothesized that children with executive function deficits would have more difficulty switching between using interactive features and listening to story content and would struggle when provided the opportunity to utilize interactive features at their leisure (as in the current study). This is another question for future research.

Visual Attention

Visual attention was measured in order to examine how children deployed their attention during book reading and to measure their engagement. Previous research has not carefully examined visual attention during e-book reading; therefore, these results provide additional descriptive information regarding children's deployment of attention and engagement. It was hypothesized that that younger children would spend more time looking off-task than older children and that children of all ages would devote more visual attention to e-book reading than to paper book reading. The results indicated that children maintained a high level of visual attention on-task during both electronic and paper book reading. As expected, older children spent more time on-task than younger children, which likely reflects their more advanced developmental stage and ability to maintain focused attention. The one-on-one nature of the book reading sessions and children's unfamiliarity with the researcher who was facilitating the book reading may have contributed to children's high levels of on-task visual attention. It may be that if children were reading in a more familiar environment with a caregiver, they would have demonstrated more off-task attention.

The results of the current study indicated that children spent significantly more time looking off-task during paper book reading compared to electronic book reading. This finding is consistent with our hypothesis and suggests that children may have been less engaged during paper book reading. It is likely that the electronic format and use of interactive features captured children's attention more consistently than did the paper storybook. This may be an advantage of electronic books, as it appears that electronic books increase children's engagement. Engagement will be discussed in more detail in the section below.

Results also revealed that children spent more time looking at the adult when reading with the paper format (compared to electronic format). Given that the adult was reading the paper story aloud, this finding is not surprising. These results are consistent with information collected from parents, which suggested that one of the reasons parents prefer reading paper books is for the opportunity to interact with their child. Parents may be noticing the tendency for children to spend more time focused on the screen when reading an electronic book and for the child to spend less time looking at them. Parents may therefore prefer reading the paper book, where they have the chance to engage face-to-face with their child. It is notable that the use of the iPad reduced but did not eliminate adult-child interaction during reading. Children continued to occasionally direct some of their attention to the adult when reading on the iPad, despite the fact that the story was being read by a recorded voice.

Engagement

One of the aims of the current study was to examine children's engagement during electronic and paper book reading. Reading engagement refers to "children's attentiveness to a storybook and their ability to sustain attention over time" (Moody et al., 2010, p. 297). Although the definition of engagement is consistent within the current literature, methods for quantifying engagement in experimental designs have varied significantly. Engagement has been measured using behavioural data (e.g. visual eye tracking), self report, teacher report and observational methods and a lack of consistency between measures has been noted (Roskos, Burstein, Shang & Gray, 2014). The current study aimed to assess engagement using a range of measures including self report, observation and visual attention data.

Results of analyses of visual attention data discussed previously suggest that children demonstrated increased engagement, as measured by looking on-task, during e-book reading. When observational coding methods were utilized, children demonstrated increased engagement in the areas of enthusiasm and persistence during e-book reading compared to paper storybook reading. This finding is consistent with previous research, which suggested that electronic storybooks have a positive effect on children's reading engagement (Moody et al., 2010; de Jong & Bus, 2002; Talley, 1994; Jones & Brown 2011). When reading the electronic book, informal observation indicated that children demonstrated increased enthusiasm by smiling often, making positive comments about the book and laughing. They demonstrated persistence by staying on task, showing interest in turning the pages and appearing engaged until the end of the storybook. Children demonstrated interest in reading the electronic book and generally appeared happy and interested when interacting with the iPad. Regarding age differences, older children demonstrated increased enthusiasm compared to younger children, while compliance did not differ among the three age groups. These findings have important practical implications for parents and educators, as children's engagement has been associated with positive outcomes related to learning from electronic books.

It is notable that in the current study, as in previous research examining story comprehension in electronic and paper formats (Grimshaw et al., 2007), electronic book reading took significantly longer to complete than paper book reading. E-book reading took longer because the researcher took time to explain the use of interactive features to the child and the child took time to utilize the interactive features that were not present in the paper books. Despite the increased duration of electronic book reading, children's

engagement did not appear to be negatively impacted, and children remained engaged for the duration of electronic book reading.

In addition to examining children's engagement using observational methods, self-report data was collected from children, given that children's preference for electronic or paper modalities can impact upon their engagement with reading. In the current study, more children endorsed a preference for the electronic book. In the current study, children often demonstrated an interest in using an iPad, which may have further contributed to their preferential selection of electronic books. Given that many children in the current sample had not previously read using an electronic book, the novelty of this medium may have impacted children's endorsed preference for electronic books. Research from school age children provides mixed results regarding children's preferences for electronic or paper books. In one study, children's ratings of enjoyment of CD-ROM stories and paper stories in a sample of 9-10 year olds did not differ between story formats. In another study, Jones & Brown (2011) found that third-grade students indicated a preference for electronic books, and reported enjoying features such as automated page turning, pronunciation of words, and read-along narration features. Additionally, large-scale surveys of American children suggest that children are increasingly interested in e-books and indicate that they would read more books if they had easy access to electronic books (Scholastic, 2013). Taken together, research to date suggests that most children enjoy using e-books as much or more than paper books. Specific features such as read-along narration, sound effects and automatic page turning may be especially appealing to children and influence their preference for electronic books.

The results of the current study, which utilized a multi-modal approach to measure engagement, provide preliminary evidence that e-books can facilitate engagement more effectively than can paper books. Previous research has suggested that increased engagement with literacy materials may translate into enhanced literacy outcomes (Bus et al, 2015, Grimshaw et al, 2007). In the current study, despite increased engagement during e-book reading, the results of reading comprehension measures did not suggest this translated into increased story comprehension. Taken together, this suggests children demonstrated increased engagement and this engagement did not impact upon story comprehension outcomes.

Communication. Children initiated significantly more communication during electronic book reading compared to paper book reading and utilized more medium specific communication during electronic book reading (e.g. How do I turn the page?). The increase in communication observed during e-book reading may be due, in part, to the increased duration of e-book reading in comparison to paper book reading. Therefore, these findings should be interpreted in light of the differences in total duration of book reading. Despite this limitation, these findings suggest that both electronic and paper book formats elicit communication from children.

One concern raised with the introduction of e-books is that the use of electronic books will reduce interaction between parent and child because children will read e-books alone. Previous research has established that e-books are most useful when read with an adult. For example, Segal-Drori et al. (2010) determined that reading e-books with an adult produced better outcomes in word reading than reading e-books alone or reading printed books with an adult. This suggests that, even in e-reading, when the book is being

read by a narrated voice, adult presence is important. In the context of the current study, children initiated conversation with the adult during e-book reading, and the results of this conversation may have assisted the child in learning from the story. Research to date clearly suggests that e-book reading should not be understood as a solitary practice in which a child reads alone.

Despite findings suggesting that electronic books have a negative impact on adult-child interaction, there is evidence to suggest that dialogic reading can occur during electronic book reading. A study by Fish and colleagues (2002) provided preliminary evidence that, in naturalistic settings using parent-child dyads, electronic storybooks can facilitate similar interactions to paper storybooks. This study did not use a control group and, although it suggests that the CD-ROM book can elicit similar interactions to paper book reading, it did not note the quality of interactions during each book reading.

The findings of the current study regarding communication during electronic book reading are in contrast to previous research that suggests that communication is enhanced and facilitated during paper book reading (Whitehurst et al., 1988; Parish-Morris et al., 2013). Our findings suggest that children initiate more communication during electronic book reading. It is notable that our study design was significantly different from previous research that has examined adult-child interaction during book reading. In the present study, the book reading session was led by an adult, who read the book aloud or sat beside the child as they interacted with the e-book, but did not initiate conversation with the child during reading. The adult did respond to comments or questions posed by the child. In previous research, parent-child dyads have been instructed to read books as they typically would at home, leaving the adult to decide how to structure reading

sessions. When taken together with the results of previous literature, it appears that parents' communication may differ between electronic and paper book reading; however, this may be due to parents' own inexperience with electronic books. It appears that adults' natural tendency is to use more dialogic language when reading paper books with their children, however, this does not mean that electronic books are incompatible with dialogic techniques. It appears that when unprompted, children will initiate communication during both types of book reading. In the current study, when researchers left communication up to the child they communicated equally during paper and e-book reading. This hypothesis is supported by previous literature which found that parents initiate more communication during paper book reading while children initiate more communication during electronic book reading (Korat & Or, 2010). Conversely Moody et al., 2010 found that children initiated more communication during the adult led traditional storybook condition.

This finding is important, as it suggests that children, who may be more comfortable with electronic technology having grown up in a digital age, initiate communication during both electronic and paper book reading. Adults may approach e-book and paper book reading in a different manner. In the future, it may be important to examine how training in dialogic reading techniques could be implemented in e-book reading in order to facilitate children's learning.

Limitations of Current Research

The generalizability of the findings of the current study is limited given that the sample recruited in the current study consisted of a homogenous group of 3-, 4- and 5-year-olds. Children in the current study were predominately Caucasian, from middle

class families, with the vast majority of parents reporting a university education. All children were enrolled in a preschool program. Parents reported spending significant time reading to their children each day and limiting overall screen time for their children. On a measure of receptive vocabulary, children in the sample achieved an average score almost one standard deviation above the population mean and, on a measure of executive function, all children in the sample were within an average range. Given the demographic and socio-economic features of the current sample, it is likely that children in the current study possessed early academic skills that facilitated their comprehension and learning from storybooks. The children in the current study had already been exposed to books frequently and had developed strong receptive vocabulary skills. Therefore, the results of the current study suggest that e-books are suitable for pre-school children who have already developed some pre-literacy skills.

In the future, it will be interesting to examine a more heterogeneous sample of children, including children not enrolled in pre-school education and children from lower-SES backgrounds. Research has begun to explore the utility of e-books for diverse groups of children and some evidence exists to suggest that electronic books are useful for facilitating literacy skills in children from low-SES backgrounds (Verhallen et al., 2006; Korat & Shamir, 2008; Talley, 1994). Korat and Shamir (2008) found that after reading with e-books, children from low SES families experienced greater improvements in emergent literacy skills than did children from middle SES families, although both demonstrated improvements. Similarly, Talley (1994) found that introducing CD ROM books into Head Start programs had a positive impact on children's emergent reading

skills and helped children "catch up" to same-age-peers with more exposure to book reading.

Directions for Future Research

Given the increasing popularity and availability of electronic books and relatively small amount of research conducted to date, there are many important research questions and diverse avenues that remain for further exploration. A review by Miller and Warschauer (2014) provides recommendations for future directions in research on electronic books for children. The authors suggest that traditional observational methods be utilized to further explore children's interactions with e-books. Additionally, novel study methodologies such as the use of eye-tracking software, stimulated recall, keystroke and screen capture tools may further assist researchers in exploring important research questions regarding e-book reading. Key areas of investigation for future research include examining which e-book features are most effective for facilitating literacy, exploring how electronic reading processes contribute to literacy development and looking at how electronic reading environments impact upon literacy development in children.

Of particular interest to the author is further developing the current line of research to examine the utility of e-books for diverse clinical populations, such as children with ADHD and learning disabilities. Although work with clinical populations is beyond the scope of the current study, results of the current study will be valuable for informing our understanding of learning from e-books among typically developing children, which will allow for comparison between typically developing children and clinical groups.

Previous research has suggested that e-books may be especially useful for children with learning disabilities due to their multi-modal (e.g. visual, auditory and sensory modalities) and interactive nature (Shamir & Baruch, 2012, Moody et al., 2010). In the future, it will be interesting to explore the efficacy of e-books to support learning in pre-school children at risk for learning disabilities, as well as to examine interventions that may utilize e-books to support children with learning disabilities.

In addition to children at risk for learning disabilities, several studies indicate that interactive media may be beneficial for children with ADHD and Autism Spectrum Disorder. Cardon (2012) found that iPads were useful for facilitating modeling behaviours among preschool children diagnosed with Autism Spectrum Disorder. Acedvedo-Polakovich, Lorch and Milich (2007) suggest that children with ADHD spend more time watching television than their typically developing peers, demonstrating a preference for visual media due to the frequent distractions and fast-pace. Based on this literature from television, it is anticipated that children with ADHD would be especially interested in using interactive electronic technology such as e-books.

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Appendix A

MEMORIAL UNIVERSITY

Dear Parent:

We are doing a study at your child's daycare centre and are asking your permission for your child to take part. This letter tells you about the project and what you and your child will be asked to do.

We hope to learn about the effect of electronic storybooks on children's attention and learning. We know that children enjoy these books because they have interactive features such as animation, sound effects and voices. They also often contain games and activities that are related to the story. Although they are fun, it may be that these interactive features are distractions that interfere with learning. Paper books are simpler and may be a better way for young children to learn about the story. We want to see how children pay attention to both story formats and how much they learn each one. We expect that parents also want to know about the effectiveness of these new e-books and hope this project will help to provide that information.

Your child will listen to two comparable storybooks from the *Berenstain Bears* series – one in e-book and the other in paper format. Afterwards, your child will be asked to recognize or recall several words, activities, or or themes in the stories. We will also rate how interested your child appeared to be in each story condition. We will also give your child a measure of vocabulary to see how many general words he or she knows. Finally, your child will play a Day-Night game where he or she has to say "day" when shown a picture of the nighttime and "night" when shown a picture of daytime. The session will be videotaped so that we can see what your child is paying attention to during each story. The videotape will not be used for any other purpose.

Most children find these activities fun and they will be encouraged to complete them. However, if at any time your child is uncomfortable, the activities will be stopped. Altogether, the session should take no more than 45 minutes. Please note that you are welcome to sit in on the session if you wish to do so.

We will also ask you to fill out a questionnaire including questions about your child's typical behaviour and about their experience with e-books and other media at home. You do not have to answer any questions you do not want to answer.

All information will be kept confidential in password protected computer files and in locked offices and retained for several years as required. When no longer needed, paper records will be shredded and computer files erased. No individuals will be identified in any reports of he study.

The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Memorial University's ethics policy. If you have ethical concerns about the research (such as the way you have been treated or your rights as a participant), you may contact the Chairperson of the ICEHR at icehr@mun.ca or by telephone at 709-864-2861.

If you have any questions about this research you may contact Dr. Mary Courage at 864-8027 or mcourage@mun.ca.

Thank you,
Mary Courage, PhD
University Research Professor

If you agree to have your child take part in this study please read and sign the consent form below:

Your signature on this form means:

- You have read the information about the study
- You have been able to ask any questions and are satisfied with the answers
- You understand what the study is about and what you and your child will be doing
- You give permission to the researchers to invite your child to participate in this study at his or her daycare centre
- You give permission to the researchers to videotape your child's session
- You understand that you and your child are free to withdraw from the study at any time, without having to give a reason

PARENT SIGNATURE:

I give permission for my child to participate in the study described above. I have been given a copy of this Consent Form to keep.

Child's Name: _____

Child's Birth Date: _____

Parent's Name: _____

Parent's Signature: _____ ***Date*** _____

Researcher's signature:
I have explained this study to the best of my ability. I provided the opportunity to answer any questions. I believe the parent fully understands what is involved in being in the study, and that he or she has freely chosen to be in the study.

_____ _____
►***Signature of researcher*** ***Date***

THANK YOU

Dr. Mary Courage
Psychology Department, Memorial University, mcourage@mun.ca

Appendix B

PEARSON ALWAYS LEARNING
CLINICAL ASSESSMENT

APPENDIX A

PPVT 4

Peabody Picture Vocabulary Test, Fourth Edition (PPVT™-4)

Author(s): Lloyd M. Dunn, PhD & Douglas M. Dunn, PhD

A measure of receptive vocabulary for Standard American English

At a Glance:

- **Administration:** 10-15 Minutes, Paper and pencil
- **Scores: Interpretations:** Age- and grade-based standard scores (M = 100, SD = 15), percentiles, normal curve equivalents (NCEs), stanines, age and grade equivalents, and Growth Scale Value (GSV)
- **Qualification level:** B,Q1,Q2-Level
- **Publication Date:** 2007
- **Ages / Grades:** 2:6 - 90+Years

Product Summary

Overview

The PPVT-4 test offers many enhancements to a vocabulary assessment that has been well respected for 50 years. This latest edition has been co-normed with the Expressive Vocabulary Test, Second Edition (EVT™-2), allowing you to make direct comparisons between receptive and expressive vocabulary performance. Quick and easy to administer, the PPVT-4 saves you valuable time—so that you can focus on implementing successful interventions.

Ideal for progress monitoring!
Unlike some other measures of vocabulary, the PPVT-2 supplies two equivalent forms of the test which contain different vocabulary items—helping ensure the individual has not "learned" the test. One form can be used prior to intervention to assess individuals' vocabulary knowledge and the alternative form can be used for re-testing to evaluate and document progress. PPVT-2 also includes a unique Growth Scale Value (GSV) which is sensitive to small changes over time.

Users & Applications

The PPVT-4-2 test is individually administered and norm-referenced. Use it to:

- Quickly evaluate receptive vocabulary with a test that requires no reading or writing
- Monitor progress using two parallel forms
- Directly compare receptive and expressive vocabulary when you also administer the EVT-2
- Move immediately into evidence-based interventions using those embedded directly into and linked into the ASSIST software
- Meet guidelines for universal screening, identifying strengths and weaknesses, and diagnostic testing in an RTI environment

Features & Benefits

- New! Form A Digital Stimulus Book – display visual stimuli on your desktop or laptop. Hotlinks and icons take you to the section of the test you want to administer. Order now
- More stimulus words (now 228 per form), with better representation of word types across all levels of difficulty
- All items evaluated for appropriateness with a diverse population
- Strengthened test floor
- Illustrations now in full color
- Modernized core vocabulary
- Identical administration and scoring procedures to PPVT-III
- New Growth Scale Value (GSV) for measuring incremental vocabulary growth over time
- Multiple levels of diagnostic analysis
- Ease of use—with the ability to administer items by complete sets of 12
- Newly designed carrying case

PPVT-4 Sample Training Item

Psychometric Information

Developed over a five-year period, the PPVT-4 test was standardized on a national sample of individuals ages 2:6–90+. More than 5,500 individuals were tested; data from approximately 3,500 subjects was used for the normative scores. The sample matches the U.S. Census for gender, race/ethnicity, region, socioeconomic status (SES), and clinical diagnosis or special education placement.

The PPVT-4 test provides extremely reliable scores, with all reliability and validity coefficients in the .90s range.

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Scoring & Reporting

Overview

Enhanced ASSIST™ scoring and reporting software offers fast, flexible, and accurate scoring & reporting, with:

- Ability to enter by item or by total raw score
- Easier data entry for unlimited numbers of students
- Multiple individual and group report options
- Embedded evidence-based interventions for individual, small group, or classroom use
- Availability for Windows® and Macintosh®

Individual Reports

- **Score Summary** includes the individual's current scores, a narrative report, and a separate Suggested Interventions Report.
- **Diagnostic Analysis** presents item-level performance classified by part of speech.
- **Progress Report** tracks repeat administrations and helps you monitor an individual's improvement over time using the new Growth Scale Value (GSV).

Group Reports

- **Score Summary** includes a list of individuals' scores, the group's average scores, and narrative text.
- **Diagnostic Analysis** includes a Suggested Interventions Report that presents interventions tied to the group's item and category-level performance.
- **Single-Group Progress Report** and **Multiple-Groups Progress Report** allow you to compare results over time for institutions, grades, or ages; focus on subsets of students or special groups of examinees, such as English Language Learners (ELL); and tailor reports to meet building, institution, or federal reporting requirements.

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Research & Resources

Presentations

PPVT-4 Brainshark Presentation

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About the Author(s)

- Lloyd M. Dunn, PhD
- Douglas M. Dunn, PhD

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Appendix C

Parent Questionnaire

Child's name: _____

Child's gender: _____

Child's date of birth: _____ (day/month/year)

Your Child's Experience with E-books and Screen Media

1. Do you have e-books for children at home? _____ If yes, how many?

   a) 0-20 b) 21-40 c) 41-60 d) more than 60

2. Do you have paper books at home? _____ If yes, about how many? ____

   a) 0-20 b) 21-40 c) 41-60 d) more than 60

3. Approximately how much time do you or other caregivers spend reading to your child with e-books (__minutes) and traditional paper books (___ minutes) on an average day?

4. As a parent, do you prefer traditional books or e-books for preschool children? Why?

_____

5. Does your child read or play with e-books on his/her own? _____

   Paper books?_____

6. How much screen time (TV, videos, computers) does you child have per day? _____

7. What is the highest level of education you have completed?

__ Some high school

__ Completed high school

__ Some post-secondary technical/trade college or university

__ Completed technical/trades program

__ Completed university degree(s)

Thank you

Appendix D

Story Recall Questions

Book: It's a Frog Thing!

1. Do you see the words that tell the story? Where? (Child should point to text.) (Yes or No)

2. What was the frog's name? RECALL: _____ (Frank/Frankie)

(a) Ernie (b) Frankie (c) Bill (d) don't know

3. What did Frank the Frog want to do in the story? RECALL: _____ (Fly)

(a) run (b) fly (c) read (d) don't know

4. Why did everyone laugh at Frankie? RECALL_____ (couldn't fly/fell in water)

(a) told jokes? (b) wore a funny hat? (c) couldn't fly/fell in water (d) don't know

5. How did Frankie feel when everyone laughed? RECALL: _____ (tired, discouraged)

(a) tired/discouraged (b) happy (c) angry (d) don't know

6. What kind of feet did Frankie have? REALL: _____ (webbed)

(a) webbed (b) flat (c)

7. What crashed into the water beside Frankie while he was swimming? RECALL: _____ (a baby bird)

(a) a plane (b) a baby bird (c) a kite (d) don't know

8. Who gave Frankie a kiss and a hug for saving the baby bird? RECALL:_____ (mother bird)

(a) the baby bird (b) mother bird (c) his dad (d) don't know

9. How did Frankie fly? RECALL: _____ (Birds with twig)

(a) Birds/twig (b) his mom helped him (c) his dad helped him (d) don't know

10. Who was proud of Frankie? RECALL: _____ (mommy, daddy)

(a) mommy and daddy (b) his friends (c) baby bird (d) don't know

Book: Leo the Lightning Bug

1. Do you see the words that tell the story? Where? (Child should point to text.) (Yes or No)

2. What was the lightning bug's name? RECALL:_____ (Leo)

(a) Tommy (b) Jack (c) Leo (d) don't know

3. What did the Mommy say Leo's name meant? RECALL: _____ (Lion)

(a) little (b) lion (c) tiger (d) don't know

4. What did Leo want to do? RECALL: _____ (Make a light)

(a) swim (b) make a light (c) run (d) don't know

5. Why were Leo's friend's laughing/giggling? RECALL: _____ (couldn't make light)

(a) couldn't make light (b) funny (c) fell down (d) don't know

6. How did Leo feel when they laughed? RECALL: _____ (sad/embarrassed/mad)

(a) sad/embarrassed/mad (b) happy (c) tired (d) don't know

7. Where did Leo hide after his friends laughed at him? RECALL: _____(cave)

(a) box (b) home (c) cave (d) don't know

8. What did he do in the cave? RECALL:_____ cried/got mad

(a) cried/got mad (b) sang (c) laughed (d) don't know

9. How did Leo finally make a light? RECALL: _____ (practiced hard; storm)

(a) practiced hard/storm (b) made a wish (c) mommy showed him how (d) don't know

10. Who got dirt in his mouth? RECALL: _____ (Lester)

(a) Larry (b) Lester (c) Leo (d) don't know

Appendix E

Coding enthusiasm, persistence and compliance variables (Skibbe et al., 2008).

Persistence. This is a measure of the extent to which the child was problem-oriented in the task. At the low extreme, the child shows no effort on the task, refuses to become involved in the task, and either flees or spends his/her time off-task, or is involved only to the extent that the experimenter enforces his/her attention to her directions and responds to questions about the task. At the high end, the child is actively engaged in the problems and attempts solutions either directly or on his/her own or through experimenter's mediating suggestions. The child may be either quiet or playful, compliant or non-compliant to the experimenter's directions, but as long as he/she shows motivation towards reading the storybook. The observer should consider this rating to reflect the child's reading efforts regardless of the degree to which the experimenter was instrumental in creating the persistence.

Rating	Description
1	Very low: Child actively tries to avoid the book reading. He/she seems to want no part in this exercise and spends as little time as he/se can get away with doing the task at all.
2	Low: Child is engaged somewhat in the task but always superficially and never with effort or concentration. For instance, the child might responds to task-related questions but does not always invest any effort in this or any of his/her own energies to do it.

3	Moderately low: child works at tasks with some diligence but efforts are mixed and she/he has no long periods of participation and interaction.
4	Moderate: Child sustains some ongoing periods of effort, but clearly avoids the story after a short period of time. Or child's persistence increases and decreases throughout the reading.
5	Moderately high: Child devotes relatively long periods of sustained attention to the task and concentrates on the book. The child attempts to follow the story. His/her persistence eventually decreases and he/she begins to lose interest in the book by prematurely turning pages or saying, "I don't know" to questions before thinking about the correct answer. The child shows a lack of concentration or disinterest.
6	High: Child concentrates, participates, and appears engaged throughout the entire story. She/he loses interest or concentration only sporadically with an overall pattern of effort on the task.
7	Very high: Child participates throughout task. He/she displays very little if any diversionary tactics requiring special effort by the experimenter to engage him/her in the task. Child works, stays engaged and interested in the storybook reading activity throughout the entire book.

Enthusiasm. Child acts with vigor, confidence, and eagerness to read the story. Child takes an active interest in the book, invests effort, and appreciates the interaction. Enthusiasm involves both a sense of balance and coordination between affect and behavior. The child should appear well integrated in the sense of directing his/her energy into the story activity without conflicting motivation or repression of feelings and with confidence that everything is okay. Enthusiasm must be scored for goal oriented behavior related to the book. Other goals or expressions of excitement used to distract the experimenter or win approval, etc. and would not represent enthusiasm here. This scale captures the affect with which the child approaches the storybook reading activity and completes the book and should not be confused with persistence (degree to which the child is problem- oriented).

Rating	Description
1	Child shows no enthusiasm. Child seems hesitant to engage in question and answers or does so mechanically and with no evidence of being interested in or excited by his/her performance (although the child may be distraught over failures). Child shows an extreme lack of confidence in his/her behavior and is affectively restrained.
2	Child is generally not enthusiastic. Child does take some active interest but primarily does not actively engage the situation.

3	Child shows some clear moments of enthusiasm and active engagement in the book but primarily does not engage the situation in this way.
4	Child shows some clear moments of enthusiasm and restraint or superficiality of effort. This may occur because the child is slow in warming up to the potential of the situation or because enthusiasm increases and decreases and is not reliably invested in the activities.
5	The child is basically interested in the book and is enthused for much of the session. There is a sense of harmony between affect and behavior and the child is generally enthusiastic, but also has major periods in which this is not the case.
6	Child demonstrates enthusiasm and coordinated affect and behavior for most of the task with only brief or minor periods in which this is not so. The child is quite eager to read the book and enjoys his/her involvement.
7	Child shows high enthusiasm throughout the task. Child approaches goals eagerly, and with some persistence when he/she encounters difficulties, and the inter coordination of affect with behavior gives the child a notable sense of energy in all activities. Child clearly jumps into the book reading task with eagerness and wants to get involved.

Compliance. This scale measures the degree to which the child shows willingness to listen to the experimenter's suggestions and to comply with her requests in a reasonable manner. At the high end, a child matches his/her behaviors to directions in a detailed fashion, The child is attentive to the experimenter and may focus his/her activity around her directions. At the low end of the scale, the child actively refuses to comply with the experimenter's directions through most of the task. The child may do so through overt denial or by acting contrary to her suggestions. At intermediate scale points the child shows a mixture of compliant and rejecting responses to the experimenter's plans, It is important to consider whether or not the child understands the directions she has been given; unclear directions which are not responded to by the child does not indicate non-compliance.

Rating	Description
1	Child rejects virtually all direction of the experimenter during tasks. Commands and suggestions may be followed at initial steps but are regularly sequenced with refusals to comply. If effect, the child does nothing asked of him/her.
2	Child shows a strong tendency toward non-compliance, but it is mixed with a few efforts to follow suggestions and directions given by the experimenter. Noncompliance is more sporadic and probably patterned to frustrating and difficulty moments of the task compared to the above level.

3	There are major isolated episodes of non-compliance during the task, or tendencies towards noncompliance throughout, thus making the interaction difficult and strained, yet, the child does comply in most situations.
4	The child seems not to be strongly invested in the noncompliance and basically complies eventually to most directives. There seems to be some purposeful noncompliance, however, that produces momentary difficulties between the experimenter and child.
5	The child basically seems compliant towards mother's demands and willing to work in collaboration with her, but the child's own schedule if activities sometimes leads to non-compliance. Child does not seem invested in rejecting the experimenter's directions, and episodes of non-compliance are brief and followed by behavior accepting of mother's leadership.
6	Child complies with virtually all major directions of the experimenter, staying on task or returning to task efforts with her direction and accepting her ideas for how to complete the task. Child might not comply to lesser details with regularity and child may be briefly noncompliant when frustrated or bored, but recovers quickly.

7	Child actively orients towards the experimenter's direction in the task ad complies with all major task instructions plus more details about specific behaviors on task. The child molds her/his behavior into a collaborative effort with mother on the tasks. Heeding her suggestions with a compliance that suggests a basic trust in her advice and direction and acceptance of her authority as a guide and argue for other approaches, but these behaviors reflect autonomy within a complaint orientation rather than intentional noncompliance.

Appendix F

BRIEF-P: Behaviour Rating Inventory of Executive Function-Preschool Version

BRIEF®-P

Behavior Rating Inventory of Executive Function®– Preschool Version

RATING FORM

Gerard A. Gioia, PhD, Kimberly Andrews Espy, PhD, and Peter K. Isquith, PhD

Instructions to Parents and Teachers

On the following pages is a list of statements that describe young children. We would like to know if the child has had *problems* with these behaviors *during the past 6 months*. Please answer *all the items* the best that you can. Please do not skip any items. Think about the child as you read these statements and circle:

N	if the behavior is	**Never** a problem
S	if the behavior is	**Sometimes** a problem
O	if the behavior is	**Often** a problem

For example, if having tantrums when told "No" is **never** a problem, you would circle **N** for this item:

Has tantrums when told "No" (N) S O

If you make a mistake or want to change your answer, ***DO NOT ERASE***. Instead draw an **X** through the answer you want to change and then circle the correct answer:

Has tantrums when told "No" (X) (S) O

Before you begin answering the items, please fill in the child's name, gender, age, and birth date, as well as your name, relationship to the child, and today's date in the spaces provided at the top of the next page. If you are the child's teacher or child care provider, please check the box next to the response that best describes how well you know the child and indicate how long you have known the child in the space provided.

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Child's Name _____ Gender ____ Age ____ Birth Date ____/____/____

Your Name _____ Today's Date ____/____/____

Relationship to Child: ☐ Mother ☐ Father ☐ Teacher ☐ Other

How well do you know the child? ☐ Not Well ☐ Moderately Well ☐ Very Well Have known the child for ☐ months ☐ years

During the past 6 months, how often has each of the following behaviors been a *problem*?	Never	Sometimes	Often
1. Overreacts to small problems	N	S	O
2. When given two things to do, remembers only the first or last	N	S	O
3. Is unaware of how his/her behavior affects or bothers others	N	S	O
4. When instructed to clean up, puts things away in a disorganized, random way	N	S	O
5. Becomes upset with new situations	N	S	O
6. Has explosive, angry outbursts	N	S	O
7. Has trouble carrying out the actions needed to complete tasks (such as trying one puzzle piece at a time, cleaning up to earn a reward)	N	S	O
8. Does not stop laughing at funny things or events when others stop	N	S	O
9. Needs to be told to begin a task even when willing to do it	N	S	O
10. Has trouble adjusting to new people (such as babysitter, teacher, friend, or day care worker)	N	S	O
11. Becomes upset too easily	N	S	O
12. Has trouble concentrating on games, puzzles, or play activities	N	S	O
13. Has to be more closely supervised than similar playmates	N	S	O
14. When sent to get something, forgets what he/she is supposed to get	N	S	O
15. Is upset by a change in plans or routine (for example, order of daily activities, adding last minute errands to schedule, change in driving route to store)	N	S	O
16. Has outbursts for little reason	N	S	O
17. Repeats the same mistakes over and over even after help is given	N	S	O
18. Acts wilder or sillier than others in groups (such as birthday parties, play group)	N	S	O
19. Cannot find clothes, shoes, toys, or books even when he/she has been given specific orders (such as "Put your shoes in the closet")	N	S	O
20. Takes a long time to feel comfortable in new places or situations (such as visiting distant relatives or new friends)	N	S	O
21. Mood changes frequently	N	S	O
22. Makes silly mistakes on things he/she can do	N	S	O
23. Is fidgety, restless, or squirmy	N	S	O
24. Has trouble following established routines for sleeping, eating, or play activities	N	S	O
25. Is bothered by loud noises, bright lights, or certain smells	N	S	O
26. Small events trigger big reactions	N	S	O
27. Has trouble with activities or tasks that have more than one step	N	S	O
28. Is impulsive	N	S	O
29. Has trouble thinking of a different way to solve a problem or complete an activity when stuck	N	S	O
30. Is disturbed by changes in the environment (such as new furniture, things in room moved around, or new clothes)	N	S	O

During the past 6 months, how often has each of the following behaviors been a *problem?*	Never	Sometimes	Often
31. Angry or tearful outbursts are intense but end suddenly	N	S	O
32. Needs help from adult to stay on task	N	S	O
33. Does not notice when his/her behavior causes negative reactions	N	S	O
34. Leaves messes that others have to clean up even after instruction	N	S	O
35. Has trouble changing activities	N	S	O
36. Reacts more strongly to situations than other children	N	S	O
37. Forgets what he/she is doing in the middle of an activity	N	S	O
38. Does not realize that certain actions bother others	N	S	O
39. Gets caught up in the small details of a task or situation and misses the main idea	N	S	O
40. Has trouble "joining in" at unfamiliar social events (such as birthday parties, picnics, holiday gatherings)	N	S	O
41. Is easily overwhelmed or overstimulated by typical daily activities	N	S	O
42. Has trouble finishing tasks (such as games, puzzles, pretend play activities)	N	S	O
43. Gets out of control more than playmates	N	S	O
44. Cannot find things in room or play area even when given specific instructions	N	S	O
45. Resists change of routine, foods, places, etc.	N	S	O
46. After having a problem, will stay disappointed for a long time	N	S	O
47. Cannot stay on the same topic when talking	N	S	O
48. Talks or plays too loudly	N	S	O
49. Does not complete tasks even after given directions	N	S	O
50. Acts overwhelmed or overstimulated in crowded, busy situations (such as lots of noise, activity, or people)	N	S	O
51. Has trouble getting started on activities or tasks even after instructed	N	S	O
52. Acts too wild or out of control	N	S	O
53. Does not try as hard as his/her ability on activities	N	S	O
54. Has trouble putting the brakes on his/her actions even after being asked	N	S	O
55. Unable to finish describing an event, person, or story	N	S	O
56. Completes tasks or activities too quickly	N	S	O
57. Is unaware when he she does well and not well	N	S	O
58. Gets easily sidetracked during activities	N	S	O
59. Has trouble remembering something, even after a brief period of time	N	S	O
60. Becomes too silly	N	S	O
61. Has a short attention span	N	S	O
62. Plays carelessly or recklessly in situations where he/she could be hurt (such as playground, swimming pool)	N	S	O
63. Is unaware when he/she performs a task right or wrong	N	S	O