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Comparing electronic and paper storybooks for preschoolers: Attention, engagement, and recall☆

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ABSTRACT

Preschool children's attention, engagement, and communication during readings from comparable electronic and paper storybooks, and their recall of story content were assessed. Seventy-nine preschoolers listened to one story on a tablet and another in paper format. The e-book contained multimedia and interactive features that activated story-related information. Dependent measures were attention to the book, the adult, and off-task; engagement and communication; recall of story content. Language and executive functioning were assessed. Results showed that (1) the e-book took twice as long to complete, (2) children were more attentive to, and engaged in the e-book, (3) children communicated more about the device during the e-book but more about the story during the paper book, (4) there was no difference in recall by format, (5) executive functioning was a stronger predictor of attention and story recall than was age. Results were discussed in relation to the cognitive theory of multimedia learning.

1. Introduction

The market for electronic storybooks for preschool children is steadily increasing, although the uptake among users in this age group is not as dramatic as it is for older children and teens (Publishers Weekly, 2014). A report from Common Sense Media (2013) indicated that 27% of 2- to 4-year-olds and 39% of 5- to 8-year-olds have read, or been read to from an e-book presented on a tablet, reader, or other mobile device. However, most of the roughly 40 min a day spent reading is still done via traditional paper books (27 min) with less time spent reading on a computer (8 min), tablet, or e-reader (5 min) (Rideout, 2014). This is consistent with the mixed feelings parents report about e-books for preschoolers, even though e-reading devices are often available in the household (Vaala & Takeuchi, 2012; Zickuhr, 2013).

The growing availability of electronic storybooks for preschool children has raised concerns that they will not only add to daily screen time, but also distract them from the story content and diminish pre-reading skills and story comprehension (Rideout, 2014). E-books may also change the nature of the parent-child interaction that occurs during reading with traditional print books and that is known to support these skills (Fletcher & Reese, 2005; Mol & Bus, 2011). Alternatively, because e-books are delivered via popular mobile devices, they might engage and motivate children to read more, provide benefit from built-in reading aids, and increase attention to the story details that support comprehension (Moody, Justice, & Cabell, 2010). Children who are engaged (i.e., interested, attentive) during reading explore the book more thoroughly, generate discussion, show an interest in the illustrations, and sustain their attention throughout the reading. Reading engagement is associated with positive short- and long-term literacy outcomes (Frijters, Barron, & Brunello, 2000; Justice, Chow, Capellini, Flanigan, & Colton, 2003; Whitehurst & Lonigan, 1998). Reading from e-books will also augment children's facility with the digital technology that is part of their daily lives (Flynn & Richert, 2015; Lauricella, Barr, & Calvert, 2009; Mol, Neuman, & Strouse, 2014; Roskos, Burstein, Shang, & Gray, 2014).

Research on these issues is in its early stages. Although well-designed e-books can facilitate learning in kindergarten and school-aged children (Miller & Warschauer, 2014; Segal-Drori, Korat, Shamir, & Klein, 2010; Shamir & Korat, 2007; Takacs, Swart, & Bus, 2015; Zucker, Moody, & McKenna, 2009), less is known about their effectiveness for younger children who are primarily read to at home. As preschoolers have immature executive functions (working memory, inhibition, cognitive flexibility) (Garon, Bryson, & Smith, 2008) there is reason to expect that they might benefit less from e-books than will older children. Preschoolers have more difficulty directing and maintaining their attention on task and may be distracted from the story content by the multimedia and touch-activated interactive features or "hotspots" that e-books typically provide (Chiong, Ree, Takeguchi, & Erickson, 2012). Moreover, preschoolers depend on parental scaffolding to direct their attention during reading and this support is diminished when the e-book software provides the narration (Parish-Morris,

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Mahajam, Hirsh-Pasek, Golinkoff, & Collins, 2013). Finally, when children have to use a mouse or finger to activate hotspots and turn pages they have to allocate some of their limited cognitive resources to point, click, and swipe while still following the narrative (Lauricella et al., 2009). To clarify some of these issues, preschoolers' engagement during reading and their recall of story detail were assessed after they listened to matched stories from an e-book and from a paper book.

1.1. Storybook reading

The literature on storybook reading indicates that this activity predicts a range of positive developmental outcomes. Among the most important are advances in language (expressive, receptive) and in emergent literacy (e.g., print awareness, vocabulary acquisition, letter knowledge, phonological awareness) that are fundamental to learning to read, engagement in reading, and achievement in school (Bus, van Ijzendoorn, & Pellegrini, 1995; Fletcher & Reese, 2005; Mol & Bus, 2011; Mol, Bus, de Jong, & Smeets, 2008; Whitehurst & Lonigan, 1998). Storybook reading also supports the development of attention, memory, narrative, and learning more generally (Greenhoot, Beyer, & Curtis, 2014; Lever & Senechal, 2011; Whitehurst & Lonigan, 1998). These gains from early exposure to books persist beyond early childhood and continue into adolescence and young adulthood (Mol & Bus, 2011).

Many of these positive outcomes are mediated by the adult-child interaction that occurs during reading (Bus et al., 1995; Fletcher & Reese, 2005). Adults' talk to children is more complex during storybook reading than it is in other contexts. They use a "dialogic" strategy (Whitehurst & Lonigan, 1998) in which they direct children's attention to key elements of the story, engage them in conversation, ask distancing questions, and provide repetitions, recasts, expansions, and explanations of the story content. These shared reading experiences scaffold children's learning and support the observed literacy outcomes, school readiness, and interest in independent reading (Mol, Bus, & de Jong, 2009; Whitehurst & Lonigan, 1998). Scaffolding is also important for e-book reading. Preschool and kindergarten children learned more language from an e-book supported by adult scaffolding than from one read without scaffolding (Segal-Drori et al., 2010; Strouse, O'Doherty, & Troseth, 2013). However, young children are increasingly "reading" e-books without adult support. For example, 58% of parents reported frequently providing children between 2 and 12 years with mobile devises to entertain, instruct, or quiet them (Digital Book World, 2015; Nielsen, 2012). There is also a trend for schools to adopt electronic formats to tutor and instruct young children (Kucirkova, 2014; Rideout, 2014; Takacs, Swart, & Bus, 2014). The impact of these new reading contexts is unclear.

1.2. E-books or paper books for preschool children?

Research in which language and literacy outcomes during e-book and paper book reading have been compared has provided mixed evidence. Results suggest that e-books can enhance learning (Ihmeideh, 2014; Korat, 2010; Shamir & Korat, 2007; Smeets & Bus, 2012), produce literacy outcomes similar to that from paper books (de Jong & Bus, 2004; Lauricella, Barr, & Calvert, 2014; Willoughby, Evans, & Nowak, 2015), or diminish comprehension and learning (de Jong & Bus, 2002; Krcmar & Cingel, 2014; Parish-Morris et al., 2013). Several factors underlie this lack of consensus. First, there have been a wide variety of methods, procedures, and materials used to study the questions of interest. These include observations of e-book or paper book reading at home with a parent as well as experiments in more formal school or research settings, with or without an adult co-reader. In some studies, e-books are presented on devices in which children navigate the book with a computer mouse, in others, they listen to stories on hand-held devices navigated with a finger, or turn the pages of a toy-like electronic console book. Sometimes there is a paper book comparison condition and sometimes there is not. In some studies, children heard the stories repeatedly and in others they had only a single reading. Second, outcome measures are diverse and have included aspects of language and literacy, parent-child engagement during reading, or the quantity or quality of communication between them. Third, there has been variability in the interactive features embedded in the e-books, making them difficult to compare with each other or with paper books. Some features include simple sound effects and animations; others have built-in interactive learning features, games, or activities that divide attention. Sometimes the features are congruent with the story and sometimes they are not. Finally, preschoolers are not uniquely defined by age; some studies include toddlers, others include preschoolers primarily at home or enrolled in childcare centers, and still others include older children in kindergarten programs. These factors, singly or collectively could affect conclusions about the efficacy of any learning format.

1.3. A theoretical perspective

The uncertainty about learning from e-books versus paper books can be informed by constructs from theories of human cognition. For example, Mayer (2005) proposed a cognitive theory of multimedia learning (CTML) which holds that effective instructional materials must be consistent with the way that the human information processing system works. Three principles guide the framework. The first, based on dual-coding theory (Paivio, 1986), is that when incoming information can be processed in both visual and auditory channels at once it is learned and retained more effectively than if it is processed in a single channel. Second, there is a limit to the amount of information that can be processed in working memory at any one time (Baddeley & Hitch, 1974; Kahneman, 1973). Third, learning is most effective when individuals are actively engaged in its processing (e.g., paying attention, organizing and integrating new information into existing knowledge) (Gopnik & Meltzoff, 1997).

Although the CTML was developed to optimize multimedia learning for the literate student, much of it can be adapted to the design and evaluation of paper and electronic storybooks for preschool children. Both formats support dual processing (visual image, narration), though the multimedia features added to e-books might enhance or diminish the effect compared to the paper books. Likewise, either format might tax working memory; e-books with too many features, or paper books with two few features that require more interaction with long term memory. Both formats permit active learning; e-books through compatible hot spots and paper books through conversation with the adult. Ultimately, the effectiveness of any application of these principles will depend on the cognitive load that the medium and the story content collectively impose on young children, whose executive functions are immature (Diamond, 2013; Fisch, 2000; Garon et al., 2008).

1.4. The current study

It is clear that many cognitive, content, and contextual factors can affect how well young children will learn from storybooks in any format. The variation among the procedures and outcome measures that have been reported in the literature further complicate the evaluation `of learning effectiveness (Miller & Warschauer, 2014; Takacs et al., 2015). With this in mind, the goal of the current research was to provide data from an exploratory study on 3-, 4-, and 5-year-olds' engagement in, and recall of story information as they listened to two matched stories, one narrated from an e-