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Storybook apps as a tool for early literacy development

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Chapter *1*

General introduction

Children today are growing up immersed in media. In the last decade, access to computers and technology use has increased tremendously, not only for adults but also for young children (DeBell & Chapman, 2003; Judge, Pucket, & Bell, 2006). A recent Dutch online survey among 1532 parents of 0- to 7-year-olds (Stichting Mijn Kind Online, 2012) showed that children in the age range of four to seven spend more than 2 hours per day in front of a screen (including television, DVD, computer/video games, smart phones, and tablet computers) which is consistent with studies in the USA (Christakis, Ebel, Rivara, & Zimmerman, 2004; Roberts & Foehr, 2008; Wright et al., 2001). In contrast, four- to seven-year-olds spend less than 30 minutes a day listening to storybooks (Stichting Mijn Kind Online, 2012). Such findings may raise concern whether time spent with electronic media takes away from time spent with storybooks (Rideout, Vandewater, & Wartella, 2003). Fortunately, technology and reading are not mutually exclusive; in the last years, there has been a massive increase in the number of storybooks that is available electronically. But how do electronic storybooks contribute to children's literacy development?

Storybook reading to promote literacy skills

Starting point of popular intervention projects such as BookStart¹ is that an early start with book reading is vital for becoming literate (Raikes et al., 2006). Children who have learned to enjoy and understand stories from an early age experience much less problems in becoming conventional readers compared to children who are not frequently read to (e.g., Bus, van IJzendoorn, & Pellegrini, 1995; Scarborough & Dobrich, 1994). Mol and Bus (2011) made plausible that both a positive attitude towards reading and well-developed literacy skills contribute to a positive spiral that lasts a lifetime: children who enjoy reading will read more often through which technical reading and oral language skills keep improving, also resulting in sustained motivation to read (Mol & Bus, 2011).

Besides stimulating interest in books, book sharing in preschool-age familiarizes children with storybook language which promotes comprehension of written texts. Apart from complex syntactical structures and decontextualized language, storybooks typically include many less familiar, sophisticated words (e.g., Sulzby, 1985). Word choices in adults' speech to children and on prime-time television are positively skewed towards the more common words (Hayes & Ahrens, 1988). Text in storybooks, by contrast, often includes low frequency

¹ www.boekstart.nl

words to specify details and story events (Hayes, 1988). Even when difficult words are rare, failing to understand these affects comprehension negatively (Carver, 1994; Hu and Nation, 2000; Stahl, 1999).

Storybooks for young children are lavishly illustrated; these detailed pictures make storybooks particularly suitable to extract meanings and derive unknown words from the book context. For instance, the text “Winnie is furious” in the story ‘Winnie the Witch’ (Thomas & Gorky, 1996) is accompanied by an illustration showing an angry-looking witch making wild movements. During shared book reading, children’s eye-fixations are focused on illustrations more than 90% of the time (e.g., Evans & Saint-Aubin, 2005). More importantly, *what* children look at in illustrations is well coordinated with the text: Children fixate more often and longer on details in illustrations that are highlighted in the story text than on elements that are not (Verhallen & Bus, 2011). When a stimulus is processed through both the verbal and visual channel this creates dual coding of information (Paivio, 1986) which increases the chance of remembering it. In line with this view, children’s story recall is superior when a narration is accompanied by pictures (Hayes, Kelly, Mandel, 1986; Greenfield & Beagles-Roos, 1988).

It has been repeatedly reported that positive effects of shared book reading on children’s vocabulary growth and story comprehension ensue from parents reading interactively. For instance, effects on children’s word learning can be enhanced when parents discuss the meaning of words during the reading session (e.g., Mol, Bus, de Jong, & Smeets, 2008; Mol, Bus, & de Jong, 2009). Actually the book reading paradigm assumes that interactive reading techniques are more effective when children are more actively involved in reading sessions with questions evoking higher levels of word learning than labeling or defining words, for instance (e.g., Ewers & Brownson, 1999; Sénéchal, 1997; Sénéchal, Thomas, & Monker, 1995).

A central question in this thesis is whether children’s interactions with electronic storybooks have similar effects on language and literacy skills as being read to by an adult: Is listening to interactive electronic books without adult support as beneficial as traditional shared book reading? In contrast to their printed counterparts, electronic storybooks put no restrictions on the number of times a story can be reread; computers, tablets (e.g., iPad) and phones never get tired of reading; and in a class full of children, there is always time for an individual reading session. Furthermore, electronic storybooks can include many extra features modeled on interactive book reading. However, in the absence of a

supportive adult electronic book reading may be less stimulating and outcomes may not be comparable with adult-child book sharing. In this thesis it is examined which facets of e-books contribute to learning outcomes in particular.

E-book potentials

Unlike traditional printed picture storybooks electronic storybooks show less homogeneity in design features (De Jong & Bus, 2003; Korat & Shamir, 2004; Roskos, Brueck, & Widman, 2009). At the least, e-books include an oral rendition of text in addition to or in stead of printed text. In some books pictures are static, similar to printed storybooks, but other books may include animated illustrations. The video books used in our studies include motion pictures that resemble a cartoon at first sight, but importantly, animations were carefully designed to focus children's attention to depictions in synchrony with the oral text. Electronic picture storybooks may also include sound effects and background music. Furthermore, some electronic stories are designed for story reading; others include games or other interactive features such as hotspots that reveal some kind of audio or visual effect. How do these e-book features affect children's language and literacy development?

Motion pictures and sound effects

Illustrations in storybooks are usually very detailed, which may complicate attempts to fixate elements that the story text highlights. For instance, in the Dutch storybook 'Rokko Krokodil' [Rokko the crocodile] (de Wijs, 2001), Rokko and his parents are watching a dozen of crocodile eggs, waiting for Rokko's siblings to appear. In the illustration, some eggs are intact, but some are broken and show a baby crocodile's snout to indicate that the animal is appearing. However, other broken eggs show a tail which could also mean that a crocodile is crawling inside the egg. By and large there is much room for errors in understanding the story language (e.g., what is meant with 'siblings' and what does 'appearing' mean?), especially considering that the child only has limited amount of time to figure it out before the story continues.

Video- and camera-effects in animated pictures may enable temporal contiguity, meaning that words and pictures are presented simultaneously (Mayer, 2001). Because motion elements attract more attention than static parts of a picture, animated illustrations can direct children's attention to relevant visual details mentioned in the oral story text if motion matches the narration.

Likewise, zoom shots -- the camera zooms in on one egg before showing that it breaks open and that a baby crocodile appears -- may also help to match pictures and text. Both motion pictures and zoom shots may facilitate simultaneous processing of text and illustrations (Schnotz & Rasch, 2005), which may make animated picture books preferable to books with static pictures.

Additional audio features in electronic books like sounds and music are perceptually salient and thus likely to elicit and sustain children's attention (Barr, Zack, Garcia, & Muentener, 2008; Calvert & Scott, 1989; Huston & Wright, 1983) which may result in increased learning especially after repeated encounters (Verhallen & Bus, 2009). However, music and sounds may also support story understanding more directly. Music may support text comprehension by stressing suspense or a character's mood (e.g., sadness or happiness). Moreover, adding the sound of *knocking* on a door, birds *whistling*, or a motor *humming* may help clarify these words' meanings. Nonverbal information is coded simultaneously with the oral text and dual coding may facilitate storage and retrieval of new language (Paivio, 1986).

Verhallen and colleagues reported beneficial effects of video storybooks on comprehension and vocabulary (e.g., Verhallen, Bus, & de Jong, 2006; Verhallen & Bus, 2010). In a series of studies, a group of second language learners repeatedly read either a video storybook or an electronic version of the same story with merely static pictures. Both vocabulary acquisition and story understanding improved most with the video book. Silverman and Hines (2009) reported beneficial effects of video on word learning for second language learners as well but failed to find this for first language learners. After a storybook reading, these researchers showed video clips with extra information about the storybook's topic (e.g., National Geographic's 'Totally Tropical Rainforests' for storybooks about the rainforest) so effects on vocabulary may be better explained resulting from more background knowledge. Chapter 2 reports a study that evaluates the benefits of multimedia in first language learners by comparing video and static versions of the same stories.

Chapter 4 discusses effects of video and static e-books in pupils diagnosed with severe language impairments (SLI). These children show significant limitations in their language abilities scoring at least 1.5 standard deviations or more below the mean in at least two out of four language areas (speech production, speech perception, grammar, or lexical-semantic). The SLI population forms a rather heterogeneous group experiencing a broad range of language deficits

(Bishop, 1997; Schwartz, 2009; van Weerdenburg, Verhoeven, & van Balkom, 2006). Similar to very young children, these children may rely more heavily on nonverbal representations than on their limited language skills (Simcock & Hayne, 2002). Consequently, video storybooks may interfere with processing the language because children might ‘look and not listen’, in line with Hayes and Birnbaum’s (1980) visual superiority effect. In an SLI subgroup, music that is embedded in video books may interfere with processing the narration because it could deteriorate speech perception just as noise does (e.g., Robertson et al., 2009; Ziegler et al., 2005). The research reported in Chapter 4 was designed to examine effects of e-books in a language impaired sample and to detect differential effectiveness for video images and background music.

Interactivity

Games. Especially since the increased popularity of touch screen devices a large body of e-books includes interactive features such as games like puzzling, coloring, or memory games (de Jong & Bus, 2003; Korat & Shamir, 2004), but there is concern for the educational quality of these stories (e.g., Roskos et al., 2009; Zucker, Moody, & McKenna, 2009). These activities might be entertaining and increase children’s motivation (e.g., Ricci & Beal, 2002), but may also promote a ‘play-mode’ rather than stimulate children to read the entire story (de Jong & Bus, 2002; Labbo & Kuhn, 2000). Because the additional features easily distract children from the story this type of interactivity may not contribute to learning from a storybook context.

Hotspots. The first generation of e-books included hotspots that triggered visual or sound effects; for instance, a tea towel changed into a dove when clicked on. In 1998, a series of Janosch stories were published on CD-ROM including many hotspots that were inconsiderate with the story line (Labbo & Kuhn, 2000). Yet some animations elaborate on story events or on words in the text. For instance, the story ‘I’ll Make You Well, said the Bear’ contains a scene where Tiger is given an injection prior to an operation. A click on the needle triggers a visualization of how the fluid spreads out in the body. Hotspots inconsiderate with the story line may attract attention at the expense of reading the story text (de Jong & Bus, 2002), but positive effects are reported when hotspots activate an animation that is consistent with the story line (Higgins & Cocks, 1999; Higgins & Hess, 1999).

Exploring more recent e-books we came across examples of hotspots that may contribute to vocabulary learning. In the storybook apps from the Dr. Seuss series (e.g., a cat in the hat), objects are defined when clicked on similar to how parents or teachers explain the meanings of difficult words (e.g., Biemiller & Boote, 2006; Dickinson & Smith, 1994; Elley, 1989). The effectiveness of hotspots that explain word meanings is tested in two experiments in the current thesis (chapters 2 and 3). For instance, in ‘Beer is op Vlinder’ (van Haeringen, 2004), a definition of the word ‘stumbling (over ones words)’ was audio recorded and linked to a hotspot in the illustration. During one interactive moment, for instance, children can click on Bear’s head (encircled green when the mouse touches it to indicate that this is a hotspot), after which the voiceover says: “Bear stumbles over his words, he is mumbling”. We expected that hotspots providing definitions would reveal similar additional effects over reading alone as adults providing definitions during reading sessions (e.g., Biemiller & Boote, 2006).

Questions. According to the book reading paradigm, children’s active involvement in extracting meanings is especially effective (Ewers & Brownson, 1999; Sénéchal, 1997; Sénéchal et al., 1995), which might mean that answering questions is more effective than simply receiving information. TV-shows for young children such as ‘Dora the Explorer’ or ‘Blues Clues’ include a ‘tutor’ who makes eye-contact with children, asks them a question, pauses for the child to respond, and then reacts to the child’s answer. Such programs have been demonstrated to support learning more than programs without this feature (e.g., Crawley, Anderson, Wilder, Williams, & Santomero, 1999). A similar design can be realized in e-books (see exemplary books on the Dutch website Bereslim²) by building in a tutor who asks questions about story events or difficult words. For instance, when Bear in the story ‘Beer is op Vlinder’ (van Haeringen, 2004) is fanning the fire, the story is interrupted for a question by the computer assistant: “Bear is fanning the fire. In which picture can you see that?” To answer the question, children can click on one of three pictures that appear on screen (the correct image among two distracters). The assistant gives feedback regarding the correctness of the response and provides clues in case of incorrect responses. In chapter 3, this questioning approach is compared with hotspots that provide definitions. Superior effects are expected for questions because these encourage children to make, rather than take meaning (Moreno & Valdez, 2005).

² <http://web.bereslim.nl>; <http://web.bereslim.nl/bereslim/bereslimme-boeken/demo-bereslimme-boeken.html>.

Outline of this thesis

This thesis describes whether electronic storybook reading can contribute to children's literacy development and how. Five experiments were designed to test the effectiveness of video images instead of static pictures, sounds and background music in addition to oral text, and interactive word meaning explanations. Knowledge about the effectiveness of e-book design features in supporting early literacy skills is not only important for evaluating and designing e-books, but can also contribute to a better understanding of vital elements of shared book reading.

The e-books that are used in these studies are all presented on a personal computer or laptop, but it is assumed that results apply to storybook apps on tablet computers and mobile phones as well. Commercial e-book providers may claim that an app differs from an e-book presented on a personal computer, yet in fact both include the same features (e.g., video images, sounds/music, games, hotspots). For interactive e-books, the hardware makes a difference regarding the way to interact with the device, either by mouse clicking or by touching. However, underlying principles of effective forms of interaction as we tested in this thesis (i.e., requiring more or less active involvement/participation from the child) apply to all e-books irrespective of the device.

Chapter 2 reports an experiment in which the effectiveness of video books is contrasted with static books in a normative sample. In line with the outcomes for second language learners, video books may promote story comprehension and vocabulary more than static versions of the same stories. It is also tested that interactive video books with word meaning explanations support word learning more than hearing the non-interactive version of the story without interruptions for clarifying words.

In **chapter 3**, it is examined whether vocabulary instructions are more effective when children are more involved in extracting meanings. In two experiments, the effectiveness of questions about difficult words is contrasted with hotspots that provide definitions of words.

Chapter 4 includes two experiments that focus on potential effects that video books may have in a language impaired sample. It is examined whether visual and audio features of video books are either beneficial or detrimental for SLI children.

In **chapter 5**, it is discussed whether independent e-book reading is an alternative for real-time adult-child storybook reading, and which e-book design features contribute to the effects of electronic storybooks.