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The efficacy of electronic books in fostering kindergarten children's emergent story understanding

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Increasingly, young children can experience electronic versions of books such as those presented by a CD-ROM, DVD, or the Internet on a computer screen. For example, in the Netherlands, where information technology is widely available, we are already noticing effects of information technology on young children's literacy experiences in the home. According to a recently published report (Mullis, Martin, Gonzalez, & Kennedy, 2003), 9% of Dutch families have educational software related to reading. These electronic books typically include multimedia effects that invite children to interact with the textual display on the computer screen.

According to our content analysis of 55 electronic books available in Dutch and published between 1995 and 2002 (de Jong & Bus, 2003), 69% of books on CD-ROM that are commercially available and that children are reading independently employ multimedia features. These interactive features allow readers to select screens and animations embedded in pictures. Animations typically entail visual and sound effects hidden in screens of electronic books and discovered by moving the cursor over a picture. Clicking on such pictures activates an animation that is often incongruous to the story (e.g., a pot in the main character's kitchen opens and a monster unrelated to the story appears with accompanying music).

Thus, in the Netherlands and other parts of the world, adults can read books to young children as has long been the case, or young children can independently experience electronic versions of those same books. But do these alternate forms produce different experiences and effects? In this study we pursued that question. Specifically, we were interested in exploring how children interact with stories on

The efficacy of electronic books in fostering kindergarten children's emergent story understanding

A COUNTERBALANCED, within-subjects design was carried out to study the efficacy of electronic books in fostering kindergarten children's emergent story understanding. The study compared effects of children's independent reading of stories electronically with effects of printed books read aloud by adults. Participants were 18 four- to five-year-old Dutch kindergarten children in the initial stages of developing story comprehension but beyond just responding to pictures. Electronic reading produced experiences and effects similar to adult-read printed books. Children frequently interacted with the animations often embedded in electronic stories, but there was no evidence that the animations distracted children from listening to the text presented by electronic books, nor that the animations interfered with story understanding. Findings suggested that children at this stage of development profited from electronic books at least when electronic books are read in a context where adults also read books to children.

La eficacia de los libros electrónicos para promover la comprensión emergente de cuentos en niños de nivel inicial

SE ELABORÓ un diseño balanceado intra-sujetos para estudiar la eficacia de los libros electrónicos en la promoción de la comprensión emergente de cuentos en niños de nivel inicial. El estudio comparó los efectos sobre los niños de la lectura electrónica independiente con la lectura oral de libros impresos hecha por adultos. Participaron 18 niños daneses de nivel inicial de cuatro a cinco años que se hallaban en las primeras fases de desarrollo de la comprensión de cuentos, apenas superada la etapa de responder sólo a las imágenes. La lectura electrónica produjo experiencias y efectos similares a los libros impresos leidos por adultos. Los niños interactuaron frecuentemente con las animaciones que acompañan a menudo los cuentos electrónicos, pero no se observó evidencia de que las animaciones distrajeran a los niños de escuchar el texto presentado en los libros electrónicos, ni tampoco de que las animaciones interfirieran con la comprensión de los cuentos. Los hallazgos sugieren que los niños en esta fase del desarrollo aprovechan los libros electrónicos, al menos cuando dichos libros se leen en un contexto en el que los adultos también leen cuentos a los niños.

Die Wirksamkeit von elektronischen Büchern zur Förderung aufkommenden Verständnisses von Erzählungen bei Kindern im Kindergarten

ES WURDE ein ausgewogenes Design innerhalb der Themen ausgeführt, um die Eindrücke von elektronischen Büchern zur Förderung des emporkommenden Verständnisses der Kinder von Erzählungen im Kindergarten zu untersuchen. Die Studie verglich Eindrücke der Kinder beim selbständigen elektronischen Lesen von Erzählungen mit Eindrücken beim lauten Vorlesen von Erwachsenen aus gedruckten Büchern. Die Teilnehmer bestanden aus 18 vier- bis fünfjährigen holländischen Kindern im Kindergarten in den Anfangsstufen der Entwicklung des Erzählungsverständnisses, jedoch fortgeschrittener als bloßes Reagieren auf Bilder. Elektronisches Lesen bewirkte Erfahrungen und Effekte ähnlich den durch Erwachsenen gelesenen gedruckten Büchern. Die Kinder gingen häufig gegenseitig auf die in den elektronischen Erzählungen eingebetteten Animationen ein, jedoch gab es keinen Beweis dafür, dass die Animationen Kinder vom Zuhören der von den elektronischen Büchern vermittelten Texte ablenkten, noch dass die Animationen das Erzählungsverständnis beeinträchtigten. Die Erkenntnisse legten nahe, dass Kinder in diesem Entwicklungsstadium von elektronischen Büchern profitierten, zumindest wenn elektronische Bücher in einem Kontext gelesen werden, wo Erwachsene ebenfalls den Kindern aus Büchern vorlesen.

幼稚園児の萌芽的物語理解の育成における電子本の有効性

幼稚園児の萌芽的物語りの育成における電子本の有効性を研究するため、釣り合いのとれている被験者間計画が用いられた。本研究は、子供達が独自に電子端末で物語りを読むことの効果と大人に音読してもらった印刷本の効果を比較した。参加者は、物語理解の発達の初期段階であるものの、単に絵に応答するレベルを超えていた４歳から５歳のオランダ人幼稚園児１８人だった。電子端末での読書は、大人が読んだ印刷本と同じような経験と効果をもたらした。子供達は、電子本の物語にしばしば埋め込まれた動画と頻繁に相互行為を行ったが、動画が、電子本によって提示されたテキストを子供達が聞くことの妨げとなったり、物語理解の妨げとなったりする証拠は全くなかった。結果から、この発達段階の子供達は、少なくとも大人が子供達に本を読んだりもする状況に電子本があるときは、電子本がためになることが示唆された。

L'efficacité des livres électroniques sur l'amélioration des débuts de la compréhension d'histoires chez des enfants de maternelle

UN PLAN expérimental contrebalancé intra-sujets a été construit pour étudier l'efficacité des livres électroniques sur l'amélioration des débuts de la compréhension d'histoires chez des enfants de maternelle. L'étude compare les effets de la lecture autonome d'histoires par des enfants aux effets produits par la lecture de livres lus à haute voix par des adultes. Les participants étaient 18 enfants hollandais de maternelle âgés de quatre à cinq ans, au moment où ils commencent à comprendre une histoire, juste après celui où ils se contentent de réagir à des images. La lecture électronique produit des expériences et des effets semblables à ceux de livres lus par des adultes. Les enfants interagissent fréquemment avec les animations qui sont souvent inclues dans les livres électroniques, mais rien n'indique que ces animations aient distrait les enfants de l'écoute du texte que présentent les livres électroniques, ni qu'elles aient interféré avec la compréhension de l'histoire. Les résultats indiquent que les enfants à ce niveau de développement tirent avantage des livres électroniques, au moins quand ils sont lus dans un contexte où les adultes lisent également des livres aux enfants.

Эффективность электронных книг для становления восприятия текста у детей дошкольного возраста

Чтобы изучить эффективность использования электронных книг для становления восприятия текста у дошкольников, было предпринято сравнительное исследование в пределах одной группы респондентов. В одном случае дети самостоятельно читали электронные тексты, в другом – взрослые читали им вслух обычные, неэлектронные издания. В исследовании участвовали 18 голландских детей четырех-пяти лет, уже перешедших от восприятия исключительно иллюстраций к начальной стадии восприятия текстов. Непосредственное общение с электронными изданиями и общение с бумажными книгами при участии взрослых имели сходный эффект. Дети взаимодействовали с элементами мультипликации, которые часто сопровождают электронные тексты, но при этом не было зафиксировано никаких свидетельств того, что мультипликация отвлекает детей от прослушивания текстов, представленных в электронных книгах, или препятствует восприятию смысла. Результаты исследования подсказывают, что на этой стадии развития детей общение с электронными текстами идет им на пользу, по крайней мере в тех случаях, когда оно происходит в том же контексте, что и чтение бумажных книг вместе со взрослыми.

the computer, how various features of electronic books affect reading, and particularly in this study to what extent, if any, reading electronic books promotes or interferes with story understanding of children who have begun to develop an awareness and understanding of stories in books.

Most electronic books for young children, in addition to the oral renditions of the text, provide unrelated interactive animations that can be accessed by clicking on parts of pictures accompanying the text. Such visual effects may distract children from the story, and, because they may encourage children to think of the story as a game, they may in turn interfere with comprehending the story (cf. Bolter, 1998; Greenfield et al., 1996; Labbo & Reinking, 1999; Leu, 2000; Smith, 2001). Researchers have started to explore the issues related to young children's experiences with printed or electronic books and have provided empirical evidence addressing those issues (de Jong & Bus, 2002, 2003; James, 1999; Labbo & Kuhn, 2000; Labbo, Reinking, & McKenna, 1995; McKenna, 1998; Reinking, 1988, 1994, 1997; Reinking & Bridwell-Bowles, 1991; Ricci & Beal, 2002; Segers & Verhoeven, 2002; Smith, 2001; Turbill, 2001), but the findings are mixed and unclear. For example, some researchers have investigated whether the comprehension of books read electronically was similar to the comprehension of an adult-read book. In our earlier work (de Jong & Bus, 2002) we found evidence suggesting that children did not recall as much of the language and story structure in electronic stories as in stories read to them by adults. The 4- and 5-year-old children in that study often did not choose to hear a story read orally by the computer, and only a few children heard the complete story even though they had sufficient time to hear the story repeatedly. One notable finding was that given a choice between interactive animations hidden in pictures and text read orally, none of the participants read the story several times. Most children selected the screens presenting the story in a random order, seemingly selecting screens with appealing animations and other interactive effects.

Results of case studies support the hypothesis that multimedia additions, such as visual and sound effects, to books on CD-ROM interfere with the narrative, which seems to undermine comprehension, particularly for children at an early stage of understanding stories. There are visual and sound effects hidden in most screens of electronic books that can be found by moving the cursor over the picture (de Jong & Bus, 2003). These animated effects, although perhaps appealing and humorous to children, are, nonetheless, irrelevant to the story they accompany, which may negatively affect investigating and understanding the story, favoring instead a more playful approach (cf. Bolter, 1998; Greenfield et al., 1996; Labbo & Reinking, 1999; Leu, 2000; Smith, 2001).

From observations of four children, James (1999) concluded that children were not successful in navigating through an entire story without being distracted by pictorial details and sound effects hidden in pictures (see also Turbill, 2001). Labbo and Kuhn (2000) speculated that Roberto, a kindergarten child with a basic concept of stories and story features, often lapsed into passive viewing because special effects in the electronic book were inconsistent with the story, and each screen contained several such inconsistent effects. They observed, "When interacting with a series of incongruent-to-story multimedia features of Arthur and his friends standing in the hallway, Roberto tended to passively watch the screen" (Labbo & Kuhn, p. 200). He seemed to enjoy the animated effects, but this affective motivation did not lead to an understanding of the story. Beck and McKeown (2001), in a study of printed books, found evidence that when the content of pictures conflicts with the events of the story, children misunderstand what is happening in the story at that point. Extrapolating from these findings with printed books, one may expect negative effects on story comprehension from visual and sound effects inserted in electronic stories.

On the other hand, Ricci and Beal (2002) did not find that visual and sound effects disrupted comprehension among a group of first-grade students. The children were able to recall many details from a story presented electronically by a CD-ROM even though they explored numerous animations inconsistent with the story while reading the electronic book. Instead of interfering with the story, the animations produced some positive effects as evidenced by the increased enjoyment that children reported on a rating scale after reading the story. In line with that result, it is conceivable that animations unrelated to the story may enhance children's engagement and motivation to explore stories and, thus, their understanding of stories (cf. Cordova & Lepper, 1996).

Electronic books, although perhaps not a satisfactory replacement for adults reading printed books to children, may nonetheless be a beneficial supplement to books read by adults, particularly when children are at a stage when their concepts of stories are just emerging. Findings from developmental studies justify the expectation that details of pictures and other parts less relevant to following a story may be-

come less distractive as children become more acquainted with stories. For example, Sulzby (1985) described patterns of 2- to 6-year-old children's emergent storybook reading behaviors when asked to read to an adult from a favorite book. She concluded that children's early development includes a shift from simply responding to pictures toward understanding stories. The least experienced children focused on events represented by the illustrations and simply labeled or commented on pictures. As children's concepts of stories develop, they begin to comprehend a story's structure. At that stage, children also begin attending to the phrasing of the story, and they increasingly show awareness and memory of the text.

Although previous research has examined the effects of electronic stories on young children's interaction with and comprehension of electronic books, none have made a distinction between children's level of development regarding stories. In the present study our aim was to clarify previous work in this area by ensuring that all of the children interacting with electronic books had moved beyond the earliest stages of simply naming pictures to a stage where they were capable of understanding stories.

Another relevant issue is kindergarten children's dependence on adults' comments to achieve higher levels of comprehension and more sophisticated linguistic expression than would be possible without interactive scaffolding (Arnold, Lonigan, Whitehurst, & Epstein, 1994; van Kleeck, Alexander, Vigil, & Templeton, 1996; Wasik & Bond, 2001; Whitehurst et al., 1988). Unlike findings among 2- and 3-year-old children, a high-input style during book reading is likely to be the least prevalent one in a somewhat older group (Bus, 2003). When reading stories to children older than 2 to 3 years old, it is more typical for adults to read texts nearly verbatim without any interruptions aimed at focusing children's attention or at explaining facets of the story (Bus & van IJzendoorn, 1995; Dickinson & Smith, 1994; Greene Brabham & Lynch-Brown, 2002; Hammett, van Kleeck, & Huberty, 2003; Martin, 1998; Pellegrini, Brody, & Sigel, 1985; Reese & Cox, 1999).

A plausible hypothesis is that kindergarten children may become less dependent on social support as soon as they can formulate stories on their own. Sulzby (1985) found that 80% of the kindergarten children in her study at the beginning of the kindergarten year and all children at the end of the year had progressed from treating individual pages of storybooks as if they were discrete units to treating the book as the unit. However, we are aware of no studies testing the hypothesis that kindergarten children who have begun to make up stories when they retell a favorite book indeed begin to understand stories read to them without much social support (Bus, 2001).

Thus, there are no firm conclusions about the effects of electronic stories, particularly those with animations, on story comprehension. Even in groups of more advanced children, animated effects associated with the pictures can stimulate a game-playing stance in preference to reading the complete text in the sequence set out by the author (cf. de Jong & Bus, 2002). It is also possible that children shift their attention to animated effects after an initial reading of a story (e.g., James, 1999). Thus, children rarely read electronic books several times in the same way adults read books to children multiple times, a technique that is used informally by parents and more formally by classroom teachers and that has shown some positive effects (Biemiller, 2003). Reading a book several times stimulates children to notice more details and to gain a deeper understanding of the story line (Philips & McNaughton, 1990), and it leads to more word learning (e.g., Sénéchal, 1997).

Clearly, adult interaction with young children during reading may be important at some stages of development, but perhaps not at all stages. Considering children at different stages of development, then, may alter conclusions about whether independent reading of electronic stories may be beneficial or detrimental. Thus, we wondered whether results from a prior comparison between a book read electronically by children independently and a book read aloud to a child by an adult (de Jong & Bus, 2002) could be obtained among a group of kindergarten children at an emergent stage of story understanding, but beyond the earliest stages defined by Sulzby (1985).

It was our aim to investigate whether narratives in an electronic book presented by a CD-ROM produced the same level of story understanding as narratives in printed books read to children by an adult. Toward explaining any differences in outcomes, we also examined in what aspects reading electronic books might differ from adults reading printed books to children. We investigated (a) how retellings of narratives presented electronically compared with retellings when books were read aloud by adults and retellings in a control condition; and (b) the characteristics, and the stability of those characteristics, of young children's interactions with narratives in electronic books.

Method

Participants

We selected a group of children whose success at achieving story comprehension after independent encounters with electronic books was uncertain. We excluded children who were known to depend heavily on adult support (i.e., children who, according to Sulzby's [1985] coding system, are not yet able to weave stories across pages, even after interactive reading sessions, and just label or comment on pictures). We focused on children who scored beyond just labeling and commenting on pictures (Sulzby's levels 1–2) but who were still in the initial stages of story comprehension. Hence, we included children only when they, according to Sulzby's scheme of independent reading of favorite books, responded on her levels 3–5: dialogic story telling, monologic story telling, and reading and storytelling mixed. Such children begin to weave stories across pages, but do not succeed in telling a complete story similar to the one in the book using the phrasing of the story in the book. We excluded children who were beyond these levels, being able to tell stories that in content and phrasing strongly overlapped with the story in the book (Sulzby's level 6 and beyond).

The participants were selected from three kindergarten classes with a total of 79 children in the same school in a small town in the Netherlands of approximately 30,000 inhabitants. To select children at Sulzby's levels 3–5 we conducted an emergent reading study. Two coders agreed that 68 children scored at these levels or beyond them. Forty-eight of these children participated in another study. Out of the remaining 20 children considered for this study at the levels 3–5, we excluded one child because of frequent absence and another child who was suspected of developing learning problems. The remaining 18 children came from three kindergarten classes (8, 8, and 2, respectively). Four children had attended school for less than one year, and 12 had attended for at least one year. The children's ages ranged from 4 years and 4 months to 6 years and 0 months (M = 5.5 years; SD = 6.3 months). There were 4 boys and 14 girls.

The school enrolled mostly children from Dutch families of low socioeconomic status. Most mothers were housewives, while the fathers were mainly manual laborers working for building contractors, in the fishing industry, or in stores. Formal teaching of reading or writing was not part of the curriculum; neither were informal emergent literacy activities such as pretending to read books or to write letters, words, or stories. Most of the school day involved several whole-group sessions including storybook reading, an oral telling of a Bible story, singing songs, and children telling about their everyday experiences. The remainder of the day was spent on paper-and-pencil tasks to stimulate classification; visual discrimination; counting; fine motor skills; and determining what came first in a series and which object was below another, bigger, and so forth. In addition, the children engaged in activities such as drawing; coloring; painting; solving jigsaw puzzles; dressing up; playing with blocks and dolls in the playroom; or playing outside in the sandbox, with bikes, on the swing, or with balls.

Design

We used a counterbalanced, within-subjects design to compare children's knowledge of three different books (Calfee, 1985). The degree to which the content and phrasing of the story told by the children overlapped with the story in the book were dependent measures (Sulzby, 1985). Each participant engaged in all three conditions: (a) exploring an electronic story that provided an oral rendition of the text, animated pictures, and supplementary animations embedded in illustrations; (b) listening to a story read to the child by an adult from a conventional printed book; and (c) a control condition (no treatment between the selection test and posttesting). The within-subject design entails a change in story from one condition to the other. To ensure that condition and story were not confounded we combined the three conditions with three different stories. Not all combinations are meaningful. We could not present the same story in two or three conditions, because we could not test learning effects. Thus the number of assigned combinations diminishes to the six in which each book appears only once. The six possible meaningful combinations of story and condition were randomly assigned to the 18 participants so that an equal number—3 children—had the same combination of story and condition and that per condition, 6 children were assigned the same story. The order of the electronic and printed book in the treatment sessions was counterbalanced between subjects (half of the children started the first session with the printed book and half with the electronic book) and within subjects (the order of the electronic and printed books was alternated; i.e., each child started 6 sessions with the electronic book and the other 6 sessions with the printed book).

Each treatment session was divided between children independently reading an electronic version of one of the stories and the experimenter reading another story to the child. We preferred this design to a design in which the two treatments are carried out in succession. When the two treatments take place in the same time frame it is unlikely that other experiences or maturation make up for any differences between the two treatments. In line with the estimate that 3–4 readings are best to support story understanding (Penno, Wilkinson, & Moore, 2002), we planned three adult-led readings of the printed book, and we provided the children with sufficient time to hear the electronic story three times.

We speculated that spending more than 15 minutes on book reading might be too demanding for some children of this age. To stay within this time frame, the three readings of the printed story were spread over 12 sessions of approximately 5 minutes (M = 4.7; SD = .6). Interacting with electronic texts that provide resources that go beyond printed material is inherently more time consuming than reading printed materials (Reinking, 1988). In total for the electronic version, we provided the children with 120 minutes spread over 12 sessions to enable them to read the story three times, as often as in the printed book condition. This estimate was based on timing how long it took to hear the complete electronic story three times as well as to activate about 240 animations (about 20 per session).

The 12 treatment sessions occurred during five weeks with 2 or 3 sessions per week. Posttesting was spread over three 10-minute sessions that occurred within two weeks directly following the treatment period. In our within-subjects design each subject participated in two treatments (CD-ROM and Book), and each served as his or her own control. Children did emergent readings for the two stories read to them during the treatment and for the control story in three subsequent sessions with stories and conditions in counterbalanced order. Control stories were never read to the participants or presented on CD-ROM. These stories were only posttested.

Procedure

The first author and four senior undergraduate students, in this article referred to as experimenters, carried out the experiment. Each of the experimenters guided each child during two or three treatment sessions according to a strict timetable. The first author did the testing. The teachers introduced the experimenters to the children as teachers and explained that they would read to them and assist them with a program on the computer.

Pre- and posttesting and the treatment sessions took place in a spare room in the school that was not in use for other purposes during the experiment. This room contained a computer installed by the experimenters, a table, two chairs, and an analogue camera in a fixed position.

All sessions were recorded on videotape. The experimenter started the camera when entering the room with a child and stopped the camera after the session was completed. During testing a child was recorded from the front. During the treatment sessions the position of the child in relation to the camera varied. Working with the computer, a child was recorded from the side to capture the computer screen as well as the child. When reading the printed book to the child, chairs were positioned so that the experimenter and child were recorded from the front.

During regular school time, the experimenter took individual children from the classroom for 10 or 15 minutes. The sessions aimed at testing the children took about 10 minutes and the treatment sessions about 15 minutes (M = 15.5; SD = .8). At the start of each session the experimenter explained the test (e.g., "You heard the story in the computer's voice. I am eager to hear you tell the story.") or the treatment (e.g., "Today I will first read *Well Again* to you and after that we will start *Traffic* on the computer.").

From a pilot study with four children, similar in age and socioeconomic status to the children taking part in the main study, we developed an explicit protocol for how the experimenters should interact with children while reading the electronic or printed versions of the books. We concluded from the pilot study, with two senior undergraduate students as experimenters, that the children's proficiency in using a mouse after some instruction was sufficient for the purposes of this study. However, we noticed in the pilot study that in the role of adult reader the experimenters made different judgments about which and how many questions and comments were needed to involve kindergarten children in the printed book. To make a comparison under internally yet also ecologically valid conditions, we created a scripted interaction based on prior observations of parents reading to 4- to 5-year-old children (Bus, Leseman, & Keultjes, 2000; Bus & van IJzendoorn, 1995; Hammett et al., 2003). We provided the experimenters in the role of adult reader with a protocol for each of twelve treatment sessions specifying (a) the exact amount of reading, (b) approximately 12 short comments and questions (M = 12.3; SD =

3.0), and (c) instructions on where to insert these comments and questions.

Some questions or comments focused on important details about pictures, such as those of main characters ("Do you see Little Bear?"), on making inferences from story events ("Do you see why the bride cannot sit on the luggage carrier?"), or on the relationship between text and picture (paraphrasing the text the experimenter pointed to the picture: "See, Little Tiger is carried first by Little Bear and then by the strong wolf and the strong goat"). For instance, the experimenter was instructed to ask, after reading the complete text of the first page of one book: "Do you see Little Tiger?" After the child has pointed to Little Tiger the experimenter was instructed to paraphrase part of the text: "He is unable to put one foot in front of the other, he just falls down." Then the experimenter was instructed to point at Little Bear asking, "Who is that?" If the child did not answer the experimenter supplied the answer. Furthermore, there was a general instruction to acknowledge spontaneous comments from the children, but not to dwell too long on them.

The first electronic book session began with an explanation of the computer program. The explanation required a mean of 3.9 minutes (SD = 1.8). We demonstrated to the children how to use the mouse, how a screen can be found with the help of an overview, how a new screen can be loaded, how an animation in the picture can be found, and how a screen can be accessed repeatedly at any point while reading. Figure 1 shows where to find in a screen the keys to the overview screen, the next or previous screen, or to reread the oral text, and where animations are hidden. Prior to the second session, this instruction was repeated briefly. The experimenter, who monitored children engaged in reading the electronic versions of the stories, rarely had to intervene to help children or keep them on task. Before the session, we told the children that the session would end when the kitchen timer sounded.

Materials

To limit variation that might be related to a specific narrative, we used a series of printed books written by the same author: *I'll Make You Well Again, Said the Bear*; *Big Party for Tiger*; and *Tiger and Bear in Traffic* (Janosch, 1986, 1990, 1991). Each book in this series contains a similar story about Little Tiger and Little Bear, the main characters, and other recurring minor characters (e.g., Aunt Goose, the Musical Duck, and Cox Box Frog). In each book the narration is structured around familiar events such as being ill, celebrating a birthday with a party, or learning to go alone through traffic. For instance, being ill leads to a series of events typical of this situation such as bandaging a painful limb, getting your favorite dish served, sleeping on the couch, getting attention from visitors, drinking medicine, visiting the physician, and being well again. These familiar events often included unexpected twists in the stories. For instance, the birthday party becomes a swimming party when a bored frog fills the house with water. The three stories are comparable in length (M = 1,817 words; SD = 420). Each book contains a series of pictures that illustrate the story but, if viewed separately from the text, are insufficient to understand the story.

Another criterion for selecting this series was that stories were available in closely matched printed and electronic form (Janosch, 1998a, 1998b, 1999). The CD-ROMs in this series combine multimedia additions (oral text and animated pictures) and interactivity (children may select screens and animations and restart or interrupt the oral reading), which is similar to 69% of electronic books published between 1995 and 2002 in the Netherlands (de Jong & Bus, 2003). In other respects this series also represents features common to electronic books. For example, like 45% of Dutch electronic books, the pictures in the Janosch books dramatize complete story scenes and not just details. Like 90.6% of the electronic books available in Dutch that include animations, congruence between story and animations was low (de Jong & Bus, 2003). For instance, 5 randomly selected screens of *Well Again* included 24 animations among which 22 were incongruent with the story (91.7%), 2 neutral (8%), and 0 congruent. On a 3-point scale ranging from mostly incongruent with the story to congruent with the story (cf. Labbo & Kuhn, 2000), we coded the animations in the Janosch CD-ROMs as mainly incongruent (interrater reliability for 14 electronic books: r = .99; de Jong & Bus, 2003). On average each screen of the Janosch series included 5 animations.

Inevitably, because we were using commercially prepared materials, there were differences between the printed and electronic versions of stories, which were choices made by the publishers. In contrast to the printed books, the text in the electronic versions was available as spoken text but not visible (see Figure 1 for a sample screen typical of the electronic mode). Because the narrations are translated from German to Dutch, and because different publishers issued the printed and electronic versions, there were minor differences in phrasing.

Coding of sessions

From videotaped electronic book reading we timed (a) how long it took to instruct children in the use of the mouse, (b) how a screen can be found with the help of an overview, (c) how a new screen can be loaded, (d) how the animations in the picture can be found, and (e) how a screen can be accessed again and again. We also coded from the videotape (a) how often children selected the overview screen, (b) how many screens were read and how often reading was interrupted, (c) whether screens were read in sequence or in random order, and (d) how many animations were activated. Two coders (the authors) coded a sample of 72 (out of 216) randomly selected videotaped 10-minute computer sessions independently (see Table 1 for means and standard deviations). Pearson product–moment correlations between the scores of two coders ranged from $r = .84$ for animations to $r = 1.00$ for total number of screens that the child heard and screens heard at least once.

From the videotaped adult-led book reading we coded whether the standard questioning and commenting process was followed. We recorded how many times an experimenter had departed from the protocol. The Pearson product–moment correlation between scores of the two independent coders for 72 randomly selected sessions was $r = .80$ (mean number of departures per session: 0.9; $SD = .03$); see Table 1.

FIGURE 1
A SAMPLE SCREEN TYPICAL OF THE ELECTRONIC MODE (FROM *IK MAAK JE WEER BETER, ZEI BEER* [I'LL MAKE YOU WELL AGAIN, SAID THE BEAR] BY JANOSCH [1998B]. COPYRIGHT BY HET SPECTRUM ELECTRONIC PUBLISHING.)

Note. (1) A digitized oral reading of the text starts automatically after a screen appears, but stops when any point on the screen is clicked. (2) While the story is narrated, the illustration on the screen is animated, dramatizing the story. (3) The next screen or a previous screen appears only when either of the toy ducks in the lower left and right corners is clicked, which simulates turning pages. (4) A click on the wind-up hare at the bottom of the screen restarts the oral text and the animation dramatizing the story. (5) Each screen provides several animations and sound effects, which can be accessed when children click on areas in which the cursor changes from a bear paw to speckles. These animations can be selected as many times as desired. (6) Clicking on the bear holding a stop sign at the bottom of the screen displays a screen showing miniature versions of all screens in order. When children click on any one of these screens, it is displayed.
The black **X** signifies where animations are hidden; for instance, after the bucket is clicked, a Native American rises out of the bucket.
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TABLE 1
VALUES OF TREATMENT SESSIONS AND PEARSON PRODUCT–MOMENT CORRELATIONS (*R*) BETWEEN SCORES OF TWO INDEPENDENT CODERS

	Coder 1 (n = 72) M (SD)	Coder 2 (n = 72) M (SD)	r (n = 72)
Total number of screens that the child heard (per computer session)	5.60 (4.00)	5.63 (3.94)	1.00
Screens heard at least once (per computer session)	4.70 (4.00)	4.71 (3.96)	1.00
Number of times that reading was interrupted (per computer session)	2.04 (2.56)	2.06 (2.50)	.99
Order of screens (per computer session)	4.21 (2.31)	4.47 (2.27)	.96
Number of visits of the overview screen (per computer session)	2.01 (2.13)	2.01 (2.12)	.99
Number of activated animations (per computer session)	33.11 (32.04)	31.33 (29.55)	.84
Number of departures from protocol (per printed book session)	.66 (1.05)	.71 (1.14)	.80

Measurements

To select children for the study, we assessed their current level of story understanding using procedures recommended by Sulzby (1985). The experimenter gave the picture storybook *Frog Is Frightened* (Velthuijs, 1994) to a child and said, "The teacher read this book to you. I was not present, but I am curious to hear the story. Please read me the story." To support their reconstruction of the story, children were able to view each page while they did the emergent reading. When children were reluctant to start, the experimenter added, "You can do it your own way." There was one child who refused to read, and this child was not considered for further participation in the experiment. The outcomes were used to select participants. A child qualified for participation only when the two independent coders agreed that the child scored at least at level 3 (dialogic storytelling) but not beyond level 5 (reading and storytelling mixed) on Sulzby's classification scheme for emergent reading. Two independent coders rescored the entire set of classifications (N = 79). The Pearson product–moment correlation between the two coders within three categories (lower than level 3 of Sulzby's classification scheme, levels 3–5, beyond level 5) was r = .96.

After the 12 intervention sessions, children did emergent readings of the three stories. The emergent reading was done in the format of the treatment because children gain the highest scores when the format is similar to that used in the treatment (de Jong & Bus, 2002; Verhallen, Bus, & de Jong, 2003). Thus, when the printed book version was read to the children we used the printed book to elicit an emergent reading; when they had explored the electronic version they did an emergent reading of the electronic format, which meant that they saw the animated pictures on the computer screen without voice. In the control condition we chose to elicit the emergent reading with the electronic format.

The experimenter elicited an emergent reading of the printed book with the following instruction: "I have read this book to you several times. I would like to hear you tell the story. Please read me this book." In the electronic book condition the experimenter said, "You heard the story in the computer's voice. I am eager to hear you tell the story. But let's agree that you only click on the little toy duck [the picture that, when clicked, displayed the next screen] to go to the next screen and not on any other spots." In the control condition the computer version was used as well. The experimenter said, "You can make up a story for the pictures in this computer program. If you are done with this picture, you click on the toy duck to go to the next screen." When children were reluctant to start, they were told again that they could make up a story. None of the children refused to do the emergent readings of the three stories. To facilitate and refine holistic coding according to Sulzby's classification scheme of emergent reading, we coded two main facets of Sulzby's coding system separately (Sulzby, 1985). With the help of verbatim transcriptions we tallied (a) how many *words* were derived from the original text, (b) how many *phrases* (at least three words in a row) were derived from the original text, and (c) the pages where the story told was similar to the original story (*story structure*). We awarded each page/screen one point when the main event of that page was indicated. See Figure 2 for examples of coding. Pearson product–moment correlations (r) between two coders for words, phrases, and story structure were .98, .97, and 1.0, respectively.

Correlations between the three measures (phrases, words, and story structure) were high (ranging from .77 to .97), and principal component analyses of the three measures, carried out for each story separately, revealed one component with loadings greater than or equal to .91. Because of this overlap we reduced the three measures to one variable that explains most variance observed in the set of three manifest variables (Tabachnick & Fidell, 1996). The new variable was based on combined *z*-scores for words, phrases, and story structure (see Table 2). We adopted *z*-scores so that all measurements, despite their different origins and unit sizes, could be converted to that single scale. Alpha reliabilities calculated for the three measures per story were greater than or equal to .94.

FIGURE 2
EXAMPLES OF TRANSCRIPTIONS AND CODING FOR THREE EMERGENT READINGS

Stimulus text	Laura	Andrea	Leendert
Page 1 One day Little Tiger came staggering out of the woods. He was unable to put one foot in front of the other. There he fell down, on the ground, in the middle of the meadow.	*He was unable to put one foot.* *Words* (*verbal*): 7 *Phrases* (*verbal*): 1 *Similarity*: 0	Here it begins. As Little Bear *one day* Little Bear *one day*, visited *tiger*. He saw at once somebody lay *down* and he went there. Calmly. And he found out it was *Little Tiger*. *Words* (*verbal*): 8 *Phrases* (*verbal*): 0 *Similarity*: 0	*One day* the *tiger* walks in *the woods* and then he stumbled over. *Words* (*verbal*): 5 *Phrases* (*verbal*): 0 *Similarity*: 0
Page 5 And when Little Tiger had eaten he felt somewhat better. But then he felt somewhat worse again because he liked to sleep soundly. "In bed," said the Little Bear. "On the couch with the soft pillows," said Little Tiger, "and tucked in with the leopard blanket." Then Little Bear laid Little Tiger on the couch with soft pillows and he tucked him in with the leopard blanket. And Little Tiger slept a while. When he woke up he felt somewhat better. But then he felt somewhat worse again because he wanted visitors.	I do not know this one. *Words* (*verbal*): 0 *Phrases* (*verbal*): 0 *Similarity*: 0	But *then he felt somewhat worse because he liked to sleep* so much. And *Little Bear* went *in bed*, no I mean, *on the couch with a soft pillow* and the hippopotamus *blanket*. You get that, you get that, said *Little Bear*. So he went to sleep well. *Words* (*verbal*): 24 *Phrases* (*verbal*): 3 *Similarity*: 1	And then they went to sleep and then he said: "I want the *soft*. I have and they the *blanket* over him and *he wanted* to have *visitors* soon." *Words* (*verbal*): 5 *Phrases* (*verbal*): 0 *Similarity*: 1

Note. Names are pseudonyms.

TABLE 2
VALUES OF OUTCOME MEASURES BY CONDITION AND BY STORY

	Electronic book *N* = 18 *M* (*SD*)	Printed book *N* = 18 *M* (*SD*)	Control *N* = 18 *M* (*SD*)
Words	154.28 (96.92)	162.94 (93.01)	38.89 (17.98)
Phrases	16.89 (13.72)	18.28 (12.53)	1.33 (1.37)
Story structure	48.61 (31.51)	75.17 (17.78)	6.78 (6.98)
Combined scores (*z*-scores)	.26 (.74)	.68 (.80)	-.95 (.18)

Notes. *Words* = mean number of words from original text that children used in the emergent reading; *Phrases* = mean number of phrases from the original text that children used in the emergent reading; *Story structure* = percentage of pages/screens that elicited a story similar to the original story; *z*-scores = words, phrases, and story structure combined.

Results

Treatment effects

Effect of treatment on story comprehension was tested with use of a multivariate analysis of variance (MANOVA) with repeated measures for the three conditions. We planned three pair-wise comparisons to test (a) if adult-led printed book reading was more effective than the control group; (b) if independent encounters with electronic stories were more effective than the control group; and (c) if, between the two treatments, the reading of the printed book to participants was more effective than the participants' reading of the story electronically. Because we planned three comparisons with only two degrees of freedom, a Bonferroni adjustment of level for each test was needed (Tabachnick & Fidell, 1996). By testing each of the three planned comparisons at alpha (α) = .017, the alpha across all tests was approximately .05. We report partial eta squared (η^2) as an indicator of how much association there is between the treatments and story understanding.

The scores in the control condition were lower than the scores that children reached in the two treatment conditions, M = -.95 (SD = .18) and M = .47 (SD = .69); see Table 2. In the control condition children scored lower than in the printed book condition, $F(1, 17) = 84.23$, $p < .001$, $\eta^2 = .83$, and in the electronic book condition, $F(1, 17) = 61.34$, $p < .001$, $\eta^2 = .78$. The mean score in the printed book condition (M =.68; SD = .80) exceeded the score in the electronic book condition (M = .26; SD = .74), but this difference was not statistically significant.

How similar were electronic book sessions to adult-led printed book reading?

Independent encounters with the electronic versions of the stories were similar to adult-led book reading in some respects but not in others. Similar to the adult-led reading of printed books, children listened to a main part of the electronic story as appeared from a 79% score on *screens heard at least once*, and they heard the story on average more than three times (see Table 3). Contrary to the adult-led reading of printed books, the text of the electronic versions was not heard in order during about half of the sessions because children often interrupted the oral reading of text (interruption of reading per session: M = 2.9, SD = 2.2) or because they selected screens in random order through the overview screen. Furthermore, children often activated animations irrelevant to the story (number of activated hotspots per session: M = 32.6, SD = 25.0).

Did electronic book sessions differ over time?

To test whether children's strategies changed after they had read the electronic story once or twice, the coded characteristics of electronic reading were analyzed with a series of 3-way analyses of variance (MANOVA) with repeated measures for time of treatment. We divided the 12 sessions into three chunks: sessions 1–4, 5–8, and 9–12; see Table 3. To explain effects of time of treatment, we conducted post-hoc comparisons. Following the procedures recommended by Tabachnick and Fidell (1996), the results of evaluation of assumptions of normality, homogeneity of variance-covariance matrices, lineari-

TABLE 3
CHARACTERISTICS OF ELECTRONIC BOOK EXPLORATION OVER TIME

	Sessions 1–12 *M* (*SD*)	Sessions 1–4 *M* (*SD*)	Sessions 5–8 *M* (*SD*)	Sessions 9–12 *M* (*SD*)
Total number of screens that the child heard	67.22 (38.31)	23.28 (14.85)	21.78 (14.78)	22.17 (14.80)
Percentage screens heard at least once	78.63 (26.88)	49.56 (32.33)	48.30 (31.96)	50.71 (28.53)
Mean number of readings per screen	3.33 (1.45)	1.58 (.61)	1.62 (.61)	1.44 (.62)
Number of times that reading was interrupted	34.50 (26.36)	16.72 (14.83) [a]	8.72 (9.22) [b]	9.06 (7.16) [b]
Number of sessions that screens were read in a random order	5.89 (3.71)	2.28 (1.32)	1.94 (1.70)	1.67 (1.57)
Number of visits of the overview screen	28.13 (26.90)	10.83 (8.93)	8.52 (9.83)	8.78 (9.65)
Number of activated animations	390.83 (299.35)	92.30 (94.07) [a]	137.87 (116.41)	160.67 (111.05) [b]

Note. 1. For most characteristics, values for sessions 1–12 are the sum of sessions 1–4, 5–8, and 9–12, but not for "percentage of screens heard at least once" and "mean number of readings per screen" because of overlap between the three chunks.
2. Superscripts a and b indicate a significant post-hoc contrast within the category.

ty, and multicollinearity were satisfactory. Skewness and kurtosis were close to zero, and Mauchley's test of sphericity was not significant (alpha = .001).

Analysis of sessions during which children interacted with electronic versions of the stories revealed differences over time in the number of interruptions of the oral reading and in the number of activated animations. At first, when the children were not yet used to reading an electronic version of a story they were less inclined to listen to long pieces of text and often interrupted the oral reading of text as is indicated by a main effect of time of treatment on number of interruptions, $F(2, 16) = 3.88$, $p < .05$, $\eta^2 = .33$. According to statistically significant post-hoc tests for sessions 1–4 versus sessions 5–8 ($p < .01$) and sessions 1–4 versus sessions 9–12 ($p < .01$), the first four ($M = 16.72$; $SD = 14.83$) sessions differed from the final eight ($M = 8.89$; $SD = 7.55$). Moreover, there was a main effect for animations, $F(2, 16) = 6.52$, $p < .01$, $\eta^2 = .45$. In later sessions ($M = 37.32$; $SD = 27.57$) children activated more animations than in the first four sessions ($M = 23.07$; $SD = 23.52$) as appeared from a statistically significant post-hoc test between sessions 1–4 versus sessions 9–12 ($p < .05$).

Discussion

The main finding of the present study is that kindergarten children who have reached a stage in which they can understand stories are able to retell a story when they experience it independently in electronic form. Children in this condition recalled about 50% of the story events using about 8.5% of words (154 out of 1,817) derived from the original narration (see Table 2). Results also revealed that children's story understanding after independently experiencing electronic versions of books is comparable with their scores after repeated adult-led book encounters. One strength of the present study is that our conclusion is based on three different stories instead of just one (Bus, van IJzendoorn, & Pellegrini, 1995).

Another finding is that when navigating through electronic books, the children proceeded much like they did in the condition where adults read to them. That is, children navigated through the story often in the sequence dictated by the story, and they initiated several readings of the same story. The children did not make a shift after one reading to a more playful approach as James (1999) suggested that children do when they listen to an electronic book. Indeed, children explored more animations in later sessions, but this shift did not imply that they then failed to comprehend the story.

The results in Table 3 show that children spent about the same time listening to story text when reading the electronic version of the book as they did when an adult read a printed book to them. Like the adult-led book reading sessions, they read most parts of the story about 3 times. That finding suggests that reading a story several times, which is quite common in daily book reading routines (e.g., Biemiller, 2003), meets children's need to hear the same story more than once (cf. Philips & McNaughton, 1990).

The present results add nuance to the argument that the animations typical of electronic stories with interactive features (de Jong & Bus, 2003) work against listening to the story text. Most children seemed engaged with the content of the electronic books. For instance, each of the six children who explored the electronic version of *Well Again* activated about 20 animations unrelated to the story in each session. Nonetheless, children heard, on average, 90% of the screens of *Well Again* 3.5 times. The finding that children remained focused on the story seems to counter the argument that the entertaining features of electronic books, which are often incongruent with the story, distract children from listening to the oral text and processing the story conventionally. These results do not, however, rule out the possibility that animations incongruent with the story would foster passive viewing and suspend efforts to make sense out of the story when children have access to numerous inserts in each screen (e.g., Labbo & Kuhn, 2000). Unlike the electronic books that Labbo and Kuhn used, there were fewer (different) animations available in the electronic books used in this study (19 or more animations per screen in electronic books used by Labbo and Kuhn and 5 per screen in the Janosch series).

Apparently kindergarten children beyond the elementary stage of just labeling and commenting on pictures (Sulzby, 1985) but still in the preliminary stages of understanding stories learn from independent encounters with picture storybooks. Unlike what a social-constructivist framework (Vygotsky, 1978) would predict, children in this study comprehended stories without adults to create a supportive context for their development and to assist children in achieving higher levels of comprehension and more sophisticated linguistic expression. However, the way in which the children interacted with electronic versions of books may have been influenced by their previous exposure to printed books with adults. Without a model of book reading routines built up by prior encounters with books read to them by adults, children's interaction with electronic versions of books might proceed differently.

The findings do not support the "visual superiority" hypothesis predicting that literacy in electronic environments has more to do with the consumption of images than listening to the narration (Bolter, 1998). Had that been the case we would have found that animated pictures distracted children from listening to the oral text. Instead, we found that electronic books do not reduce learning about the story language. When exploring an electronic book, children were apparently as focused on the oral text as the printed text read to them by an adult.

The findings also fail to support the hypothesis that animations incongruent with the story work against construction of story knowledge. The study did not reveal any evidence that incongruent animations interfere with children's story comprehension. Apparently young children at this stage of development are already successful at deriving story meaning without being inordinately distracted by animations, many of which are incongruent to the story.

Limitations and future directions

Adult readers were strictly guided in their interactions with the children as they steered the child repeatedly through the story. Having to follow a scripted protocol may result in a book reading session with responses to children that are more stilted and therefore not as sensitive to young children's individual needs compared to more authentic adult–child interaction. In other words, the possibility cannot be ruled out that reading printed books under more typical circumstances—better adapted to the individual child's needs—might have revealed effects different from the present level of book understanding after three readings.

Further clarification is needed about whether features of electronic books are essential to supporting story understanding and whether the present results can be generalized to electronic books that vary from the series of electronic stories used in this investigation. Because we did not include an electronic book condition without animated pictures, the present design does not permit conclusions about any positive effects of electronic books devoid of such animations. Likewise, studies are still needed to ascertain whether interactive capabilities of electronic books make screens more attractive to young readers, and thus more likely to support their interest and repeated reading of text. We also wonder whether exploring the animations, even if knowledge of a story's plot is decreased, might lead to increased vocabulary, more interest in reading in general, or more requests for an adult to read the book conventionally.

Main conclusions and practical implications

To summarize, it may be concluded that prereaders, who are beyond labeling and commenting on pictures but still in the initial stages of story understanding and unable to decode text, can become acquainted with new stories from independent encounters with stories in electronic books such as the ones used in the present study. Kindergarten children at this early stage of development generally listen to the complete story in the order set out by the author more than once, in a similar way to adults reading printed books to them. From these findings we cannot, however, conclude that electronic books can replace adult-led book reading. The way in which children independently experience electronic versions of books may have been influenced by their presumably repeated exposure to reading printed books with adults or by their literacy interest (Frijters, Barron, & Brunello, 2000). We hypothesize that without a model of book reading routines built up by other adult-led book encounters, interaction with electronic books might proceed differently and perhaps not as effectively as in this group of kindergarten children.

The present findings suggest that alternative ways of encountering stories may be a useful addition to adult-led book reading at home and in kindergarten classrooms (Labbo et al., 1995). Electronic books do meet kindergarten children's developmental needs without placing a heavy demand on adult support. Books presented electronically by a computer offer a viable option for those educators who are looking for alternative ways to provide kindergarten children with occasions for listening to stories. Electronic books, therefore, might be useful in allowing children who have the capability to understand stories to engage in independent reading before they are capable of reading conventional printed texts on their own.

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