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Quality of Book-Reading Matters for Emergent Readers: An Experiment With the Same Book in a Regular or Electronic Format

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An adult read to 12 children from a regular paper book. Twenty-four children explored an electronic book similar in illustrations and story content (also called CD-ROM storybook, talking book, interactive book, or computer book). For half of this group the electronic book was available with and for half without restrictions concerning the games. Twelve control children were only pre- and posttested. After 6 sessions the examiner elicited an emergent reading of text and separate words to test to what extent children had internalized story meaning, phrasing, and features of written text. During the book-reading sessions children's attention to text and iconic modes differed as a function of book format and children's level of emergent literacy. The regular book format was more supportive of learning about story content and phrasing; both formats supported internalization of features of written words.

In the extensive storybook reading literature, there is agreement on the assumption that early book-reading experiences support children's reading development (Bus, van IJzendoorn, & Pellegrini, 1995; Scarborough & Dobrich, 1994; Teale, 1984). Our study focuses on what emergent readers internalize from repeated readings of books that are similar in illustrations and story content but differ in format (regular vs. electronic). The book's format was expected to affect which aspects of books children focus on within the sessions and what children internalize from repeated readings of the focal book. We also tested how much children at different levels of emergent literacy internalize from various aspects of a book as a consequence of repeated readings of the focal book. It was expected that basic knowledge of reading built up by previous literacy-related experiences facilitate internalization of various aspects of each new book that is read to children (cf. Pappas, 1993).

Sulzby's (1985) description of what children internalize from a repeatedly read book suggests that least experienced children focus on events represented by the illustrations and just label or comment on pictures. As children's reading experiences increase they begin to represent the story structure, suggesting that story understanding develops in the early stages of emergent literacy. It may also be deduced from Sulzby's (1985) scale of emergent reading of a favorite book that as children become more experienced in understanding the story structure they begin to focus on the phrasing of the story. They internalize verbal text as a result of repeated readings, resulting in increasingly verbal reproductions of the text in the focal book or refusals to continue reading when attempts to reproduce the verbal text fail (Sulzby & Zecker, 1991). The most experienced children are interested in the written form of the text and begin to use text as a source of information when they reconstruct stories. Sulzby (1996) assumed that, in particular, children with emerging knowledge of letter–sound relationships pay attention to the written text during book-reading sessions and begin to memorize features of the text from repeated readings of the same book.

The book-reading paradigm also assumes that these internalizations from repeated readings of the same book depend on the extent to which these various aspects of books are emphasized within the reading sessions. Several studies have shown that adults facilitate children's understanding of the story by engaging them in discussions and by explaining the events or making connections between book events and children's own lives (e.g., Bus & van IJzendoorn, 1995; Neuman, 1996). To the best of our knowledge, there is no test of the assumption that rereading the complete text numerous times particularly facilitates internalization of the story content and verbal text (e.g., Morrow, 1988; Phillips & McNaughton, 1990; Sulzby, 1985). As children's attention is more focused on the written equivalent of pronounced words, they may internalize features of written words as cues to reproduce stories (e.g., Mason, Peterman, & Kerr, 1989; Murray, Stahl, & Ivey, 1996; Smolkin, Conlon, & Yaden, 1988). Pointing during reading and text features may support these internalizations (Ehri & Sweet, 1991).

In the present study, we focus on internalizations as a function of various book formats. Paper versions of picture storybooks are typically read to a child in a fixed order, with more or less attention to story comprehension and phrasing during adult–child interaction. The illustrations in picture storybooks support comprehension. Paper books are not usually read just once but repeatedly. With the increasing impact of computers on daily life, young children may also come across electronic picture storybooks (Bolter, 1998; Lewin, 1998; Parham, 1995; Reinking & Bridwell-Bowles, 1991; Shade, 1994). Electronic picture storybooks are commercially available, particularly for the age range of 3 to 6 years. These books offer options, in addition to the text and pictures in the paper versions, and may thus broaden children's experiences. The electronic books are typically equipped with sound, animations, and games to be activated by the child (Lancy & Hayes, 1988; Reinking, 1997).

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Electronic books dramatize the word and story meanings, thus supporting internalization of story content and a book's vocabulary (Greenfield et al., 1996; James, 1999; Matthew, 1996; McKenna, 1998; Reinking, 1994). Dramatizing the story may fix children's attention on implicit meanings in the text and so add to their story understanding (Greenfield & Cocking, 1996; James, 1999; Kamil, Intrator, & Kim, 2000). Information on story meanings and vocabulary is more memorable when it is processed both visually and verbally (Kamil et al., 2000). Electronic books permit read-alouds of the complete text of each page independent of adults (Lewin, 1997; McKenna, 1998). Just the number of options available with the electronic texts may make repeated readings more attractive and thus help to internalize the story content and verbal text. Even so, when children have a choice of several ways of exploring a book they may not take advantage of all available options. The numerous options may even turn into a disadvantage when children cling to some options at the expense of other ones.

The electronic format is better equipped than the paper book format to focus children's attention on text features. The computer programs let children activate reading of words, phrases, or pages in any order they want. As the option of reading text is activated, the text may turn blue or become underlined while it is read aloud. Like books with special text features as text in balloons or text in bold print (Mason et al., 1989; Smolkin et al., 1988), electronic book options may support internalization of written word features and stimulate the development of word recognition (Lewin, 2000; McKenna, 1998).

Reading patterns may vary as a function of the basic knowledge of reading that children have developed as a result of book-reading experiences and other literacy-related activities, especially when children have a choice of several ways of exploring a page. As children have more problems understanding the story and the text in the electronic book, they may turn more to the iconic modes at the expense of the verbal representations in the book (Anderson-Inman & Horney, 1998; Greenfield et al., 1996; Kozma, 1991). As long as children lack notions of how the print relates to sound, they may ignore electronic book options that provide pronunciation of separate words. These children may not notice text features during book-reading sessions even when the text turns blue during read-alouds or flashes after clicking on icons (cf. Sulzby, n.d.).

In a number of studies, the effects of book-reading on subsequent language and literacy skills have been evaluated (see for reviews, Bus et al., 1995; Scarborough & Dobrich, 1994). Researchers typically focused on the effect of the frequency of parent–preschooler reading, paying less attention to the effects of qualitative characteristics of book-reading. In contrast, in the present study, we first tested how much book format facilitates attention for meaning, phrasing, and text features, comparing reading of a regular and electronic form of the same picture storybook. Second, we tested how the book format relates to internalizations of story meaning, verbal text, and word recognition (cf. Arnold, Lonigan, Whitehurst, & Epstein, 1994; Sénéchal, LeFevre, Thomas, & Daley, 1998), thus exploring the potential of electronic books for kindergartners learning to read (Leu, 2000). Third, assuming that internalizations from a book build on previous learning from book-reading and other literacy-related activities, we expected children to internalize more from the focal book as they have developed more basic knowledge of reading through previous experiences. We tested how reading sessions and subsequent internalizations differ as a function of children's level of emergent literacy.

Method

Participants

In all, 48 kindergarten children (4- to 6-year-olds) were selected from four different classrooms of the same school in a small town in the Netherlands (about 30,000 inhabitants). Similar to most Dutch kindergartens, formal teaching of reading or writing including instruction of letters was not part of the curriculum. On average, the school recruited children from Dutch families of low socioeconomic status. Most mothers in these families were housewives, and the husbands were mainly manual laborers working for building contractors, in the fishing industry, or in stores. Children diagnosed by the school as having learning disabilities were excluded from participation in the study. Prior to the study, all of the children did a rereading of a story that the teacher had read to them three times. Children scoring at Sulzby's Level 3 (a story-like retelling) and beyond were recruited to participate in the study. We excluded one child who was able to read in a conventional way (Sulzby's Level 11). In this way, 55 out of 120 candidate participants remained.

On the basis of the level of emergent reading as assessed with a letter test, a rhyming test, a word dictation test, and a word reading test, children were divided equally in a low, middle, or high level of emergent literacy. Thus, 19 boys and 29 girls remained. As can be deduced from Table 1, the high-level group scored higher than the other groups on letter knowledge, writing words, and a word reading test. This group knew 12 letters on average, they wrote some invented spelling, and they were able to read 10% of a word list. The low-level group did not succeed in reading words (0% correct) and they did not know the letter names and sounds, but they used emergent strategies: They wrote their name using letters or pseudo-letters, but not yet conventionally. They often connected letters to words ("that's my mom's letter"). They used pseudocursive scribble or letter-like forms when they wrote words. In reading and letter knowledge, the middle-level was similar to the low-level group. On the word reading and letter test, they reached mean scores of 0.2% of the words and 1.3 letters correctly recognized. However, they used more advanced strategies in name writing, word writing, and rhyming than did the low-level group. They wrote their name conventionally; they began to use conventional letters to represent words, but the writing was not phonetic; and almost all of the children (81%) were able to rhyme.

The groups were significantly different in age. The low-level group was on average 4 years and 8 months old (range: 50–63 months); the middle-group, 5 years and 6 months (range: 58–71 months); and the high-level group, 5 years and 11 months (range: 65–78 months). All of the children in the low-level group were junior kindergartners, whereas all of the children in the high-level group were senior kindergartners. The middle group was a mixture of 6 junior and 10 senior kindergartners. Whereas the senior kindergartners had been attending school for more than a year, junior kindergartners had attended for less than a year.

Design

Children from each of the three levels were randomly assigned to four groups: regular book group, computer book group (restricted), computer book group (unrestricted), and control group. In the regular book group, the paper version of the book was read to the children by the examiner. The computer book groups explored the electronic version of the same book. The electronic book included games in addition to text and pictures. Children in the restricted condition were not allowed to play these games, but children in the unrestricted condition were. The unrestricted condition is therefore most representative for how children normally interact with electronic books. The computer sessions were interrupted after

Table 1
Characteristics of the Low-, Middle-, and High-Level Group

Measure	Level			$F(2, 45)$, $\chi^2(2)$, or z
	Low	Middle	High	
Mean age (in months)	55.69 (4.60)	65.69 (3.55)	71.13 (3.98)	$F = 59.29$**
Junior (jr.)–senior (sr.) kindergartners (*n*)	16 jr.–0 sr.	6 jr.–10 sr.	0 jr.–16 sr.	$\chi^2 = 32.90$**
Girls–boys (*n*)	10 girls–6 boys	8 girls–8 boys	11 girls–5 boys	$\chi^2 = 1.22$, *ns*
Mean letter knowledge (max = 26)	0.19 (0.40)	1.31 (1.78)	11.56 (7.38)	$\chi^2 = 26.16$**
Mean rhyming (unable = 0; able = 1)	0.19 (0.40)	0.81 (0.40)	1.00 (.00)	$\chi^2 = 26.06$**
Writing words (mean scores per word on a scale ranging from 0–13)	5.64 (2.98)	8.28 (1.98)	11.57 (0.95)	$F = 30.82$**
Name writing (mean scores per word on a scale ranging from 0–13)[a]	7.62 (2.28)	12.69 (0.48)	12.94 (0.25)	$F = 61.83$**
Reading words without icons (mean % correct)	0.00 (0.00)	0.20 (0.82)	9.55 (15.99)	$z = -2.89$*
Reading words with icons (mean % correct)	20.40 (12.88)	31.30 (10.97)	41.73 (19.36)	$F = 8.26$**

Note. Standard deviations are given in parentheses. max = maximum.
[a] Winsorized means.
* $p < .01$. ** $p < .001$.

about 15 min because reading the text including clicking once on each illustration took about 15 min in all. Finishing the whole book in the regular book-reading group took about 17 min. The six training sessions were spread over about 2½ weeks.

All of the children completed the six pretests in the same order spread over four different occasions. Children were posttested with the same set of tests but in a somewhat different order. During the first two posttesting sessions, children did emergent readings of the paper and electronic version of the focal book. Children started with the version used during the intervention. During the third posttesting session, children read words without icons, and during the fourth, words with icons. During the last session, letter knowledge, rhyming, name writing, and word writing were tested in that order. Both pre- and posttests were spread over about 3 weeks.

Procedure

Testing and intervention were carried out in a separate room without any interruptions and with only the examiner present. All of the sessions were videotaped with a camcorder in a fixed position. The original intention was to create more or less interactive sessions. For instance, within noninteractive paper-book-reading sessions, the children listened to an audiotaped reading of the book while the children had the book in front of them. The tape included instructions for page turning and for pointing at icons on the cover pages while the words underneath the pictures were pronounced. The examiner interfered only when children were not attentive or forgot to turn a page. During the interactive paper-book-readings, the examiner read the book to the child. The examiner pointed at the text while reading and had the child fill in words where the nouns were replaced by icons. At every session the examiner pronounced all of the icons on the two cover pages where the icons were combined with the written word.

Because discussions about meaning (e.g., "What do you think is in the package?") appeared to be rare, we decided to ignore interaction as a condition and compare the three main conditions (regular book-reading, computer with games, computer without games). The simple story did not provoke discussions about the story's meaning. On average, the examiner commented only once on the story during each session. In the computer conditions, the examiner did not initiate any talk about story meaning because such discussions would have interrupted the natural flow of child activities. Prior to the computer sessions, the examiner explained the options in the program. Within the sessions, the examiner explained options when children had problems or asked for help. This occurred about five times in each session. In the restricted computer group, children were instructed not to click on game buttons. The examiner stopped the game loading when children accidentally clicked on a game.

Focal Book

P.B. Bear's Birthday Party was selected partly because both a paper (Davis, 1994a, 1995) and electronic version of this book (Davis, 1994b, 1996) were commercially available. Both formats were similar in content and design. The story tells about P.B. Bear who celebrates his birthday party with his four friends, Lucy the lamb, Dermott the dog, Hilda the chicken, and Russell the rabbit. One of his birthday presents is a train that P.B. Bear and his four friends take to go out for a birthday picnic. The illustrations are photos of toy animals. In both versions, the text fills about one half of each page printed in a large-sized font type.

In many respects both versions are similar but the format is typical for the medium. Like the paper book version, the electronic version has a title on every page that summarizes the meaning of the text. For instance, on the page where P.B. Bear has breakfast it says, "having breakfast." This title is automatically read when a new page is loaded. The texts have a rebus-like format, as icons replace most nouns. In the paper book version, the meaning of icons in the text is explained on the cover pages. Both pages present all icons with the words written underneath the picture. In the computer version, children can find the written and spoken form of the icon by clicking on it. When the word has been said, the animation stops and the written form disappears again. The paper version includes 17 games, such as finding a little bear that is hidden somewhere on the page. A choice of game is offered on 10 out of 18 pages of the electronic book. Most games include objects and characters from the story, but the content of the games is only indirectly related to the story. For instance, one game is to match variously formed birthday cards with envelopes.

Each page of the electronic version has several hot spots to be recognized by the cursor (a skewed arrow) turning vertically: the text, icons, and the illustration. Clicking on the illustration dramatizes the story. For example, after clicking on the hot spot in the illustration of P.B. Bear surrounded by birthday presents, he starts unwrapping the package as is described by the text. The book facilitates speech feedback for complete stories, single text phrases, and individual words. Text always turns blue as it is read aloud. When clicking on rebus-like icons that replace almost all nouns in the text, the written word appears simultaneously with short (4.5 s) animations and their pronunciation. Most of these animations represent the meaning of the nouns in the text. For instance, the drum starts to move and sound like a drum. Not all animations generated by clicking on icons supported children's understanding. For instance, the animation of

the bathrobe shows a belt moving around the robe and sounding like a choo-choo.

The paper book text (907 words) is about twice as long as the computer version (492 words). The computer text is shorter because many text details are designed as games. For instance, in the paper book version P.B. Bear bakes a birthday cake. The text explains how P.B. Bear proceeds. In the electronic version, this part of the text is transformed into a game option on this page. When children click on the game button, a screen appears with ingredients for a cake and other objects. The child's task is to select ingredients for a cake. The computer text is spread out over 18 pages (screens), whereas the book format includes 16 double pages.

Coding of Reading Sessions

Exploring the electronic book. For each of 144 videotaped computer sessions (6 sessions for 24 children), we coded how many pages were explored, how many pages were read by clicking on the trumpet button, how many pages were read by clicking on successive text lines, how many lines of text were read by clicking on text fragments, how many different pages were read, how often icons were activated, and how often illustrations were explored by clicking on hot spots in the illustration. For the unrestricted computer group how many games were started was also coded. Pearson product–moment correlations between the scores of two independent coders ranged from $r = .98$ for clicks on text fragments to $r = 1.00$ for clicks on trumpet button as well as clicks on animations and games.

Questions and comments. For all 216 reading sessions, we coded—for examiner and child separately—how often each initiated discussion of meaning (e.g., "how old is P.B. Bear?") or computer options (e.g., "what happens when I click on this?"). For children, we also coded their responses to tasks in the text (e.g., "find the little bear") and how often they spontaneously supplied or repeated text. The average Pearson product–moment correlation between scores of two independent coders was .95, ranging from .81 for discussion of meaning initiated by the examiner to 1.00 for discussion of meaning initiated by examiner, discussion of procedure initiated by the child, and responses by the child to the task in the text.

Tests

Emergent reading of a picture storybook. Prior to the intervention, all children did an emergent reading of a picture storybook that the teacher had read three times to the class (see Table 2). As described above, the selection of participants was partly based on this test. The examiner instructed children as follows: "The teacher read this book to you. I am anxious to hear the story too. Please read me the book." When children were hesitant about starting, they were then told that they could read "their own way." The examiner explained that it did not have to be like "grown-up reading." Further encouragement was not necessary to start children. Videotaped retellings were coded using Sulzby's 11-point-scale of emergent readings. Scores ranged from *no story formed*, through *a story formed using oral or written language*, to *reading with text as a source of information* (cf. Sulzby, 1985).

Table 2
Tests That Were Used as Pre- and Posttests

Tests	Pretest	Posttest
Emergent reading of a book that the teacher had read three times to the children	X	—
Emergent reading of *P.B. Bear's Birthday Party* (paper book)	—	X
Emergent reading of *P.B. Bear's Birthday Party* (electronic book)	—	X
Word recognition without icons	X	X
Word recognition with icons	X	X
Letter knowledge	X	X
Rhyming	X	X
Name writing	X	X
Word writing	X	X

Emergent reading of P.B. Bear's Birthday Party (paper version). After the intervention, all of the children read the paper version of *P.B. Bear's Birthday Party* to the examiner (see Table 2). When children were familiar with the paper version the examiner said, "I have read this book to you several times. I would like to hear the story in your voice. Please read it to me." When this format was unfamiliar to the children because they were part of the control group or one of the computer book groups, the examiner said, "You have read another book to me once. You did very well. Please read me this book." When children hesitated to start, encouragement was similar to the one described earlier. With the help of verbatim transcriptions of the rereadings, coding was performed per page—whether the story was similar to the story of the book, how many words in the emergent reading were derived from the original text, and whether they paid attention to text (involving pointing, commenting on text, naming letters, or attempts to decode words). We calculated the percentage of pages where the story told was similar to the book story and where children paid attention to text. To calculate which percentage of the text was reproduced verbally, the number of words in the emergent reading equal to the original text was divided by the total number of words in the original text. When the format differed from the practiced format, the percentage of verbal text was calculated by dividing the verbal text by the total number of words in the practiced format. Two coders scored all protocols independently. Pearson product—moment correlations ranged from .89 for story meaning (similarity with the original story) to 1.00 for percentage of verbally reproduced text.

Emergent reading of P.B. Bear's Birthday Party (electronic version). After the intervention, all of the children read the electronic version of the focal book as well (see Table 2). When children were familiar with the electronic version, the examiner said, "You heard this story in the computer's voice or in the voice of P.B. Bear's friends. I would like to hear the story in your voice. Please read it to me. This time you may only click on the button that turns the page." When the electronic version was unfamiliar to the children, the procedure was similar to the one described earlier except for an explanation of how to turn the page ("to turn the page you click here"). Even when the format was new to children, they mostly started to read without further encouragement. Two coders scored all protocols independently and reached high agreement on similarity between the story told and the original story, amount of verbally reproduced text, and attention to text. Pearson product–moment correlations were .91, .96, and .85, respectively.

Word recognition without icons. All of the nouns from the focal texts were listed in written format. Because some nouns differed in the book and electronic format (e.g., sandwich vs. bread), two slightly different lists were composed. As a result of differences in text length, the list for the book format included more words than the list for the electronic format, 81 and 61 words, respectively. The examiner asked the children to read the words "their own way." When children indicated that they were unable to read the words, the session was stopped, unless the examiner had the impression that they might know some words. The number of correctly pronounced words was counted. On 10 randomly selected protocols, the Pearson product—moment correlation between the scores of two independent coders was .99.

Word recognition with icons. The same word list was presented but with icons added to the written format. The number of correctly pronounced words was tallied. On a random selection of 10 protocols, the Pearson product–moment correlation between two independent coders was 1.00.

Letter knowledge. The examiner presented a sheet with all 26 letters randomly ordered on the page and printed in lower case. All of the children

appeared to know that the signs were letters. The examiner then asked, "Do you know some of the letters?" No further encouragement was offered. The score was the total number of correct letter or sound names. On a random selection of 10 protocols, the Pearson product–moment correlation between scores by two independent coders was 1.00.

Name writing. The examiner asked the child, "Please write your name for me." Children wrote on unlined, blank paper with a pen. The scale derived from Levin and Bus (2001), ranging from 1 to 13, reflects the number of represented features of writing (linearity, variety, three or more signs, letter forms, one phonetic letter, etc.). Scores 9 and beyond are attempts to write phonetically. On a random selection of six protocols, the Pearson product–moment correlation between scores of two independent coders was .99.

Word writing. The examiner dictated nine nouns. It was emphasized that they could write "their own way"; "It doesn't have to be grown-up writing." All nine words referred to persons or objects. In pilot tests, many kindergartners were familiar with some of the dictated words (the original Dutch words are italicized), namely, dad (*papa*), mom (*mama*), doll (*pop*), and fish (*vis*), but not with the rest, namely cheese (*kaas*), bag (*zak*), seesaw (*wip*), flippo (*idem*), and sun (*zon*). The writings were coded with the same scale as was used to code name writing. Two coders coded six randomly selected protocols. We calculated children's mean score per word. The Pearson product–moment correlation between the scores of the two coders was .99.

Results

Characteristics of Computer Sessions

In the unrestricted condition, where games were accessible, children spent almost half of the time (43%) playing games. On average, the children played 4.85 games (SD = 1.98) per session (see Table 3). Time spent with games and number of games were analyzed with 3 (Session Number: 1&2, 3&4, 5&6) × 3 (Level: high, middle, low) multivariate analyses of variance (MANOVAs), with Level as between-subject factor and repeated measures for Session Number. (Both here and further on, assumptions for MANOVAs are discussed only if they are unsatisfactory.) Time spent with playing games did not change over sessions, $F(2, 8) = 1.64$, *ns*; neither did the number of games, $F(2, 8) = 1.68$, *ns*. There were no significant effects involving Level.

Mean number of explored pages was analyzed with a 3 (Level) × 2 (Condition: computer without and with games) × 3 (Session Number) MANOVA, with Level and Condition as between-subject factors and repeated measures for Session Number. When games were accessible (unrestricted computer condition), children explored half as many pages as in the restricted computer group, with a significant effect of Condition, $F(1, 18) = 5.24$, $p < .034$, $\eta^2 = .226$. Children explored more pages later in the experiment than at the start, as reflected by a significant effect for Session Number, $F(2, 17) = 5.68$, $p < .013$, $\eta^2 = .400$. Scores on the first two sessions (6.83 pages) were lower than scores on the last four sessions (8.67 pages), $F(1, 18) = 11.89$, $p < .003$, $\eta^2 = .398$. In the restricted condition (no games allowed), the number of pages explored increased, whereas the number of pages remained about the same in the unrestricted condition, leading to a significant interaction between Session Number and Condition, $F(2, 17) = 3.71$, $p < .046$, $\eta^2 = .304$. In particular, for higher level children in the restricted condition, the number of explored pages increased in the later sessions, resulting in a significant three-way Session Number × Level × Condition interaction, $F(4, 34) = 3.38$, $p < .020$, $\eta^2 = .285$.

Table 3
Mean Number of Various Activities in the Computer With and Without Games Conditions by Level

Measures	Activities															
	M no. of games per session			*M* no. of pages explored per session			*M* no. of pages read per session			No. of different pages over 6 sessions (max = 18)			*M* readings per page over 6 sessions			% explored pages that are also read
	Without and with games	Without games	With games	Without and with games	Without games	With games	Without and with games	Without games	With games	Without and with games	Without games	With games	Without and with games	Without games	With games	Without and with games	Without games	With games
All levels	4.85	—	4.85	8.06	10.21	5.92	2.60	3.54	1.65	7.88	9.67	6.08	1.97	2.45	1.48	34.98	38.96	31.01
	(1.98)		(1.98)	(4.77)	(5.55)	(2.58)	(2.17)	(2.46)	(1.35)	(5.58)	(6.17)	(4.48)	(1.14)	(1.28)	(0.74)	(22.60)	(23.97)	(21.43)
Low	5.67	—	5.67	7.00	9.75	4.25	1.33	1.29	1.38	4.25	4.25	4.25	2.16	2.33	2.00	27.98	19.27	36.69
	(2.26)		(2.26)	(6.06)	(7.84)	(2.01)	(0.50)	(0.52)	(0.57)	(2.05)	(2.87)	(1.26)	(1.12)	(1.45)	(0.87)	(18.04)	(11.57)	(20.57)
Middle	4.42	—	4.42	9.54	11.25	7.83	2.42	3.04	1.79	7.38	8.00	6.75	1.95	2.81	1.10	28.19	33.23	23.14
	(1.93)		(1.93)	(5.03)	(6.71)	(2.50)	(1.65)	(0.98)	(2.08)	(5.13)	(4.24)	(6.50)	(1.58)	(1.81)	(0.77)	(21.68)	(21.16)	(24.11)
High	4.46	—	4.46	7.65	9.63	5.67	4.04	6.29	1.79	12.00	16.75	7.25	1.78	2.21	1.35	48.79	64.38	33.19
	(2.05)		(2.05)	(2.93)	(2.05)	(2.33)	(2.86)	(1.93)	(1.37)	(6.09)	(1.89)	(4.79)	(0.64)	(0.60)	(0.31)	(23.58)	(10.09)	(23.39)

Note. Standard deviations are given in parentheses. Max = maximum.

Table 4
Hot Spots and Buttons Selected Per Page in the Computer With and Without Games Conditions by Level

	Clicks on									
	Illustration		Icon		Text line (read text fragment)		Trumpet (read whole page)		Text lines (read whole page)	
Measure	Without games	With games	Without games	With games	Without games	With games	Without games	With games	Without games	With games
All levels	11.46 (4.60)	5.78 (2.65)	22.94 (11.14)	15.22 (9.39)	18.17 (10.35)	7.32 (3.79)	2.53 (2.21)	1.61 (1.35)	0.74 (1.02)	0.04 (0.08)
Low	12.79 (7.40)	5.25 (1.51)	18.54 (11.12)	7.79 (1.99)	16.54 (12.78)	4.08 (0.73)	1.04 (0.21)	1.33 (0.64)	0.25 (0.50)	0.04 (0.08)
Middle	12.33 (3.42)	5.63 (2.55)	28.46 (10.69)	18.42 (9.63)	17.29 (12.17)	10.38 (4.37)	2.83 (0.76)	1.75 (2.11)	0.21 (0.32)	0.04 (0.08)
High	9.25 (1.13)	6.46 (3.99)	21.83 (12.21)	19.46 (10.75)	20.67 (8.26)	7.50 (5.56)	3.71 (3.52)	1.75 (1.31)	1.75 (1.17)	0.04 (0.08)

Note. Standard deviations are given in parentheses.

The selected hot spots and buttons reflected which parts of each page were explored. Clicks on hot spots and buttons were analyzed with a 4 (selected Hot Spots/Buttons: trumpet, text phrases, icons, illustration) × 3 (Level) × 2 (Condition: computer without and with games) MANOVA, with Level and Condition as between-subject factors and repeated measures for Hot Spots/Buttons; means and standard deviations can be found in Table 4. As expected, children clicked less on Hot Spots/Buttons when games were accessible, with a significant effect of Condition, $F(1, 18) = 24.03$, $p < .001$, $\eta^2 = .572$. Children clicked more on Hot Spots/Buttons that elicited animations (the icons and the illustration) than on Hot Spots/Buttons that elicited reading (disconnected or connected text fragments or the trumpet), $F(4, 15) = 51.73$, $p < .001$, $\eta^2 = .932$. This effect was strongest in the unrestricted computer group, with a significant two-way Hot Spots/Buttons × Condition interaction, $F(4, 15) = 4.74$, $p < .011$, $\eta^2 = .558$. Higher level children clicked more on Hot Spots/Buttons that elicited reading, whereas lower level children clicked more on Hot Spots/Buttons in the illustration. According to Roy's criterion, the Hot Spots/Buttons × Level interaction was significant, $F(4, 16) = 3.65$, $p < .027$, $\eta^2 = .477$.

The selection of Hot Spots/Buttons occurred to the same extent over the sessions with exception of the trumpet option. The number of clicks on the trumpet decreased, as reflected by a main effect of Session Number, $F(2, 17) = 5.03$, $p < .019$, $\eta^2 = .372$. This option was more frequently selected in the first two sessions (on average 2.96 times per session) than in the subsequent sessions (on average 1.63 times per session), $F(1, 18) = 9.89$, $p < .006$, $\eta^2 = .355$.

In the computer conditions, many pages were loaded without the full text being read by the computer. On average, no more than 35% of all loaded electronic book pages were read in full by clicking on the read-aloud option (Table 3). Thus, both computer groups read about 2.60 pages per session. Note that all 16 pages were read to the paper book group in each session. Mean number of pages read aloud was analyzed with a 3 (Session Number) × 3 (Level) × 2 (Condition: computer without and with games) MANOVA, with Condition and Level as between-subject factors and repeated measures for Session Number. Children in the restricted condition elicited read-aloud options for more pages per session (3.54 pages) than children in the unrestricted condition (1.65 pages), $F(1, 18) = 11.15$, $p < .004$, $\eta^2 = .382$. There was a main effect for Level, $F(2, 18) = 7.74$, $p < .004$, $\eta^2 = .462$. The high-level group activated more reading per session than the middle- and low-level groups. The middle- and high-level groups read more pages in the restricted than in the unrestricted condition: There was a significant two-way Level × Condition interaction, $F(2, 18) = 5.79$, $p < .011$, $\eta^2 = .391$. In the high-level group, Condition produced the strongest effect. In the restricted condition, high-level children read about one third of the book per session (6.29 pages), whereas in the unrestricted condition, they did not read more than one eighth (1.79 pages). Overall, the number of pages decreased across sessions, with a main effect of Session Number, $F(2, 17) = 4.42$, $p < .029$, $\eta^2 = .342$. Children read more pages on average in the first two sessions than during the last four sessions.

How many different pages were read in full by activating read-aloud options over all six sessions was analyzed with a 3 (Level) × 2 (Condition: computer without and with games) univariate analysis of variance (ANOVA), with Level and Condition as between-subject factors. Not all pages of the electronic book were read at least once (see Table 3). The children in the computer conditions read 7.88 different pages over all six sessions. Children in the restricted condition read more different pages by activating read-aloud options, with a main effect for Condition, $F(1, 18) = 4.79$, $p < .042$, $\eta^2 = .210$. The high-level children read more different pages than the middle- and low-level children, with a main effect of Level, $F(2, 18) = 7.56$, $p < .004$, $\eta^2 = .456$. The high-level group read about two thirds of all pages, whereas the middle group read less than one half, and the low-level group no more than one fourth of the book. The low and middle levels read about the same number of different pages in both conditions, whereas the high-level group read more different pages in the restricted condition. There was a marginally significant two-way Level × Condition interaction, $F(2, 18) = 3.31$, $p < .060$, $\eta^2 = .269$. The high-level children in the restricted condition were the only group that read the full text at least once.

Mean readings per page over all six sessions were analyzed with a 3 (Level) × 2 (Condition: computer without and with games) ANOVA, with Level and Condition as between-subject factors. Children reread the pages twice on average. In the restricted condition, children read the same page more often than in the unrestricted condition, 2.45 and 1.48 times, respectively, with a main effect of Condition, $F(1, 18) = 4.65$, $p < .045$, $\eta^2 = .205$. Most children activated read-aloud options in bits and pieces. Only

Table 5
Effects of the Intervention on Internalizations of Story Meaning, Verbal Text, and Textual Features Derived From the Emergent Readings of the Familiar and Unfamiliar Formats

	Internalizations														
	% of pages that evoke original story					% verbal[a]					% of pages where text is attended				
Measures	Total condition	Book reading	Without games	With games	Control group	Total condition	Book reading	Without games	With games	Control group	Total condition	Book reading	Without games	With games	Control group
							Familiar format								
All levels	27.72	47.22	30.56	26.39	6.71	6.33	10.42	9.31	5.01	0.57	21.71	35.00	25.46	10.65	15.74
	(31.96)	(42.09)	(30.93)	(25.75)	(8.16)	(8.03)	(10.14)	(9.57)	(3.82)	(0.93)	(35.59)	(42.18)	(41.74)	(25.01)	(29.75)
Low	18.92	47.92	13.89	9.72	4.17	3.55	8.62	1.27	3.86	0.45	16.04	8.33	23.61	26.39	5.83
	(22.80)	(21.92)	(16.67)	(15.96)	(5.32)	(4.34)	(5.63)	(1.32)	(2.47)	(0.58)	(30.09)	(6.38)	(47.22)	(41.91)	(7.88)
Middle	24.83	43.75	11.11	34.72	9.72	5.57	9.12	5.94	6.04	1.17	22.71	25.00	50.00	2.78	13.06
	(30.45)	(51.54)	(18.70)	(18.36)	(11.45)	(6.08)	(10.16)	(3.78)	(4.67)	(1.41)	(36.31)	(41.23)	(51.52)	(3.21)	(22.56)
High	39.41	50.00	66.67	34.72	6.25	9.86	13.51	20.73	5.13	0.08	26.39	71.67	2.78	2.78	28.33
	(38.94)	(57.74)	(16.36)	(35.83)	(7.98)	(11.15)	(14.91)	(6.65)	(4.73)	(1.00)	(41.22)	(43.67)	(3.21)	(5.56)	(48.19)
							Unfamiliar format								
All levels	26.39	40.74	22.92	26.39	15.51	3.61	8.71	3.00	2.22	0.54	11.13	17.13	17.22	3.89	6.30
	(28.21)	(38.44)	(23.33)	(27.26)	(16.35)	(6.05)	(9.12)	(4.26)	(3.68)	(.66)	(23.97)	(30.56)	(34.75)	(6.64)	(10.30)
Low	14.06	16.67	10.42	14.58	14.58	1.07	2.15	0.86	0.81	0.47	13.26	9.72	26.67	5.00	11.67
	(17.70)	(22.68)	(15.77)	(14.23)	(23.94)	(2.06)	(3.71)	(1.47)	(1.63)	(0.73)	(21.96)	(19.44)	(36.51)	(10.00)	(15.75)
Middle	28.65	52.78	16.67	25.00	20.14	3.70	12.18	0.61	1.17	0.84	7.99	2.78	25.00	0.00	4.17
	(27.25)	(36.71)	(18.00)	(28.05)	(13.10)	(6.53)	(9.05)	(1.22)	(0.97)	(0.70)	(25.01)	(5.56)	(50.00)	(0.00)	(8.33)
High	36.46	52.78	41.67	39.58	11.81	6.07	11.79	7.52	4.67	0.30	12.15	38.89	0.00	6.67	3.06
	(34.08)	(48.96)	(26.35)	(36.24)	(13.68)	(7.38)	(11.09)	(4.67)	(5.82)	(0.61)	(26.00)	(45.13)	(0.00)	(5.44)	(3.56)

Note. Standard deviations are given in parentheses.
[a] Winsorized means.

one high-level child read the book once in order, across all the sessions.

Effects of the Intervention on Emergent Readings of P.B. Bear in a Familiar and Unfamiliar Format

Reproducing the story's meaning and memorizing the verbal text (Table 5) were analyzed with 4 (Condition: computer with games, computer without games, paper book-reading, and control) × 3 (Level) × 2 (Stimulus Book: familiar vs. unfamiliar) MANOVAs, with Condition and Level as between-subject factors and repeated measures for Stimulus Book. When children practiced with the paper book, the computer was the unfamiliar format, and vice versa.

The familiar and unfamiliar format revealed about the same number of stories very similar to the story in the focal book, 28% and 26%, respectively. There was a main effect for Condition, $F(3, 36) = 3.34$, $p < .030$, $\eta^2 = .218$. The book-reading condition evoked significantly more original stories (44% of the pages) than did the control condition (11%), $t(24) = 3.16$, $p < .030$ (Scheffé).

To eliminate effects of three multivariate outliers, the analysis of verbal reproduction of the original text was based on winsorized means (Hampel, Ronchetti, Rousseeuw, & Stahel, 1986). After a transformation (inverse), assumptions of normality and homogeneity of variance–covariance matrices were satisfactory (Tabachnick & Fidell, 1996). The familiar format elicited more verbal reproduction than the unfamiliar format, $F(1, 36) = 10.94$, $p < .002$, $\eta^2 = .233$. Children reproduced 6.3% (ranging from 0 to 26%) and 3.6% (ranging from 0 to 21%) of the practiced text, respectively (winsorized means, not transformed). There was a significant effect of Condition on the percentage of verbally reproduced text, $F(3, 36) = 6.69$, $p < .001$, $\eta^2 = .358$. Children in the book-reading condition, restricted computer condition, and unrestricted computer condition each used more verbal text from the original story than control children; ts (24) were −4.05, −3.34, and −3.39, respectively, ps $< .05$ (Scheffé). Children in the book-reading, restricted, unrestricted, and control group reproduced on average 9.6%, 6.2%, 3.6%, and 0.6% from the original text, respectively (winsorized means, not transformed).

Attention to text was analyzed with nonparametric tests because assumptions of normality were not satisfactory. Overall children paid more attention to text in the familiar format than in the unfamiliar format, on 22% and 11% of the pages, respectively. Wilcoxon Signed Ranks Test revealed a significant effect of Format, $z = -2.66$, $p < .009$ (Monte Carlo, two-tailed). There were no significant effects for Condition and Level.

Effects of the Intervention on Recognition of Words Derived From P.B. Bear

As can be deduced from Table 6, word recognition with icons was easier than word recognition without. Word scores with and without icons were 40% and 4% correct, respectively. Word recognition with icons was analyzed with a 2 (Point-of-Measurement: pre- and posttesting) × 4 (Condition) × 3 (Level) MANOVA, with Condition and Level as between-subject factors and repeated measures for Point-of-Measurement. Word recognition with icons improved from an average score of 31% correct to 48%, as

Table 6
Improvement of Word Recognition With and Without Icons by Level

Level	Words without icons (%)					Words with icons (%)				
	Total	Book reading	Without games	With games	Control group	Total	Book reading	Without games	With games	Control group
Total										
Pretest	3.25 (10.10)	5.35 (10.32)	5.74 (17.02)	1.23 (3.77)	0.68 (1.63)	31.14 (16.98)	35.60 (18.77)	35.38 (19.20)	26.37 (15.10)	27.22 (14.16)
Posttest	5.61 (17.34)	11.52 (24.12)	9.02 (24.26)	0.96 (2.84)	0.96 (2.84)	48.28 (30.22)	79.94 (25.46)	52.19 (24.36)	35.52 (22.31)	25.47 (17.53)
Low										
Pretest	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	20.40 (12.88)	27.47 (12.11)	30.33 (2.84)	9.84 (13.18)	13.97 (9.97)
Posttest	0.33 (0.75)	0.93 (1.18)	0.41 (0.82)	0.00 (0.00)	0.00 (0.00)	35.07 (29.43)	70.06 (30.94)	32.79 (18.79)	20.08 (23.28)	17.35 (11.03)
Middle										
Pretest	0.20 (0.82)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.82 (1.64)	31.30 (10.97)	23.77 (18.07)	34.02 (6.61)	30.74 (5.89)	36.66 (8.53)
Posttest	0.46 (0.85)	0.62 (1.23)	0.41 (0.82)	0.41 (0.82)	0.41 (0.82)	48.04 (23.88)	71.91 (27.78)	49.59 (8.92)	45.08 (4.34)	25.58 (23.13)
High										
Pretest	9.55 (15.99)	16.05 (12.71)	17.21 (28.25)	3.69 (6.33)	1.23 (2.46)	41.73 (19.36)	55.56 (3.63)	41.80 (34.76)	38.52 (6.35)	31.03 (13.80)
Posttest	16.04 (27.69)	33.02 (34.72)	26.23 (39.55)	2.46 (4.92)	2.46 (4.92)	61.73 (32.34)	94.84 (2.11)	74.18 (24.26)	41.39 (27.90)	33.49 (17.23)

Note. Standard deviations are given in parentheses.

reflected by a significant Point-of-Measurement effect, $F(1, 36) = 46.71$, $p < .001$, $\eta^2 = .565$. There was a main effect for Level, $F(2, 36) = 9.89$, $p < .001$, $\eta^2 = .354$. The high-level group tended to recognize more words than the middle group, $t(32) = 2.23$, $p < .097$ (Scheffé), and recognized significantly more words than the low-level group, $t(32) = 4.44$, $p < .001$ (Scheffé); 52%, 40%, and 28%, respectively. There was a main effect for Condition, $F(3, 36) = 10.27$, $p < .001$, $\eta^2 = .461$. Children in the paper-book-reading condition scored higher than children in the unrestricted computer condition, $t(24) = 4.30$, $p < .002$ (Scheffé), and the control condition, $t(24) = 5.04$, $p < .001$ (Scheffé), and children in the restricted computer condition higher than the control group, $t(24) = 2.30$, $p < .008$ (least significant difference [LSD]). Children in the four conditions recognized on average 58%, 44%, 31%, and 26%, respectively. The paper-book-reading and the restricted computer book condition improved more from pre- to posttest than the rest, with a two-way interaction Point-of-Measurement × Condition, $F(3, 36) = 15.38$, $p < .001$, $\eta^2 = .562$. The paper-book-reading group improved from 36% to 80%, the restricted computer group from 35% to 52%, the unrestricted computer group from 26% to 36%, and the control group remained about the same, 27% and 25%, respectively.

Because of violations against normality, the scores on word recognition without icons were analyzed with nonparametric tests. A Wilcoxon Signed Ranks Test revealed a significant Point-of-Measurement effect, $z = -2.28$, $p < .025$ (Monte Carlo, two-tailed). Word recognition improved from 3% to 6% correct. Children who recognized at least three words on the pretest ($n = 7$) improved more than the rest ($n = 41$) with a pretest score of zero or a chance score of, at most, two words. The two groups improved on average 15.09 and 0.19 words, respectively. A Mann–Whitney *U* test revealed a significant difference in progress, $z = -3.45$, $p < .001$ (Monte Carlo, two-tailed). Without exception, the 7 children who made progress were part of the high-level group. The four conditions were comparable in pretest scores but did not improve to the same extent. According to a Kruskal–Wallis test, growth in word recognition from pre- to posttest differed significantly, $\chi^2(3, N = 48) = 9.50$, $p < .018$ (Monte Carlo). Children in the book-reading and restricted computer condition made more progress than the other two groups. A planned trend analysis to test a linear relationship with book-reading and restricted computer condition, on the one hand, and unrestricted computer and control group, on the other, was significant, $\chi^2(1, N = 48) = 5.13$, $p < .025$ (Marascuilo & McSweeney, 1977).

Effects of Intervention on Letter Knowledge, Rhyming, Name Writing, and Word Writing

The scores on letter knowledge were analyzed with nonparametric tests because of violations against normality. Letter knowledge improved from 4.4 to 5.1 letters correct, leading to a significant effect of Point-of-Measurement (Wilcoxon Signed Ranks Test), $z = -2.86$, $p < .004$ (Monte Carlo, two-tailed). Effect of Level on letter knowledge on the pretest was analyzed with a Kruskal–Wallis Test. The high-level children knew significantly more letters than did the middle- and low-level children, $\chi^2(2, N = 48) = 26.16$, $p < .001$ (Monte Carlo); scores were on average 11.6, 1.3, and 0.2 letters, respectively. The high-level group was the only group that improved (from 11.6 to 13.6 letters

correct). There was a significant effect for Level (Kruskal–Wallis test) on growth scores, $\chi^2(2, N = 48) = 18.59, p < .001$ (Monte Carlo). Improvement was not related to the intervention.

The effect of Level on rhyming (a dichotomous variable) was analyzed with a chi-square test. Almost all children of the middle-level group (81.3%) and all children of the high-level group were able to rhyme on the pretest, whereas only 18.8% of the low-level group could rhyme, $\chi^2(2, N = 48) = 26.06, p < .001$ (Monte Carlo). The low-level children improved from 18.8% to 31.3%, reflected in a significant effect of Point-of-Measurement, $\chi^2(2, N = 48) = 32.00, p < .001$ (asymptotic, two-tailed). There were no significant effects involving Condition.

Name and word writing were analyzed with 2 (Point-of-Measurement: pre- and posttest scores) × 3 (Level) × 4 (Condition) MANOVAs, with Condition and Level as fixed factors and repeated measures for Point of Measurement. To eliminate effects of two multivariate outliers, the analysis of name writing was based on winsorized means (Hampel et al., 1986). Children of the middle- and high-level groups wrote their name conventionally, whereas the low-level group mainly used random letter strings resulting in a main effect of Level, $F(2, 36) = 64.94, p < .001, \eta^2 = .783$. The low-level group was the only group that could improve, reflected in a significant Point-of-Measurement × Level interaction, $F(2, 36) = 4.32, p < .021, \eta^2 = .194$. There were no significant effects involving Condition.

The high-level group wrote dictated words phonetically, the middle group made letter strings, and the low-level group letter-like forms resulting in a main effect of Level, $F(2, 36) = 40.61, p < .001, \eta^2 = .693$. Writing did not improve during the experiment. There were no significant effects for Point-of-Measurement or Condition on this measure.

Discussion

Well-studied facets such as the frequency of book-reading (Bus et al., 1995; Scarborough & Dobrich, 1994; Teale, 1984) or adult–child interaction (e.g., Arnold et al., 1994; Bus & van IJzendoorn, 1995, Neuman, 1996) have made us aware of the importance of book-reading routines but leave many questions concerning the learning process unanswered. We expected that new techniques such as electronic books could clarify where children focus on within-reading sessions and how differences in attention affect what they learn from book-reading. To the best of our knowledge the present study is the first one that tests how book format (regular vs. electronic) affects attention for meaning, phrasing, and text features, and how differences resulting from book format relate to children's internalizations of these facets of the focal book.

Reading electronic books yields different experiences with a book compared with reading a regular book (cf. Labbo & Kuhn, 2000). The iconic modes of electronic books (clicking on games, illustrations, and icons) attract 4- to 5-year-olds' attention at the expense of reading the full page and text fragments (cf. Greenfield et al., 1996). After six 15-min sessions, the difference in the number of readings was dramatic. In the regular book-reading condition, the complete story was read to all children six times. Most children in the computer condition heard not more than about half of the text, 1.5 to 2.5 times. Only a minority in the restricted computer condition (no games accessible) heard the complete story more than once but at most two or three times. With games (the condition most representative of how children normally interact with electronic books), children heard even fewer pages in full, and less frequently. It is not plausible that the somewhat longer duration of the book-reading sessions (1 to 2 min each session) is to blame for this difference. In all, iconic facets of electronic books have a stronger appeal to children in the present age range than does the story text, as is also suggested by a decrease of reading text with subsequent sessions.

These book-format-related differences in the reading process blur to some extent when children are more advanced in emergent literacy. When children had a choice of several ways of exploring a book, like in the restricted computer condition, lower level children focused more on illustrations, whereas text had more appeal to high-level children who were more acquainted with the written language register and features of written text. In the restricted computer condition, the most advanced group read the complete book more than twice (2.21 times), whereas the least advanced children activated the read-aloud options for less than one fourth of the book during six sessions, on average 2.33 times. The latter had a preference for exploration of animations and icons. When games were accessible, the difference between levels vanished. Then, all of the children played games about half of the time at the expense of reading the text. Games distract children's attention from other options regardless of children's level.

Qualities of Sessions Matter for What Children Internalize From the Book

There is evidence that story understanding requires a number of repetitions of the full text (cf. Morrow, 1988). Only children in the regular book-reading condition knew the story content better than those in the control condition. The book-reading children heard the story more often than those in the computer conditions, as well as in order. In line with Sulzby's (1985) scale of reading a favorite book, 4- to 5-year-olds internalize the story language as an effect of book-reading. Regular book-reading as well as computer conditions promoted internalization of verbal text as indicated by scores exceeding those of the control group. Internalization of verbal text does not require a minimum number of repetitions. Children memorized text even in the computer conditions, where they heard just fragments not in order.

Note that with the unfamiliar book format as a stimulus to elicit an emergent reading, children reproduced half as much verbal text as with the familiar book. We hypothesize that children were more inclined to summarize the unfamiliar text in their own words than to use the phrasing of the original text because they noticed minor differences in length, letter size, color, and layout between the familiar and unfamiliar text. In line with this observation we also found that the familiar text format elicited more pointing at text, commenting on text, or word-reading attempts than did the unfamiliar format. Children seem to internalize features of text as a result of repeated readings even when they do not use the letters as a main source of information (cf. Teberosky, Martí, & Garcia-Milà, 1998).

In the book-reading and restricted computer condition, children made progress in word reading with and without icons. Exploration of the connection between the iconic, written, and spoken forms of story words may be the best explanation for this effect. In

both the book-reading condition and the restricted computer condition, the iconic modes of words were often visible in combination with the written word that was spoken simultaneously. In the unrestricted condition, on the other hand, where this effect did not occur, children spent about half of the time playing games, at the expense of clicking on icons. Exploration of icons fits better in the computer book format than in the paper book format. The paper book format requires paging to one of the cover pages to find the written forms, whereas clicking on the icons in the computer book yields the written word that is spoken simultaneously. Clicking on the icon also elicits an animation to make this option even more attractive.

Most children made progress in word reading, but only when the written form of words was presented with icons suggesting that they internalized the book's vocabulary but not features of written words. Contrary to the predominating view that experiences with books support only story comprehension and vocabulary (cf. Arnold et al., 1994, Sénéchal et al., 1998), the present findings show that some 4- to 5-year-olds also internalize features of the written text as a result of book-reading (cf. Sulzby, 1985, 1996). A small proportion of the children improved in recognizing words without icons. Note that this effect was reserved for the high-level group with some letter–sound knowledge. In line with the hypothesis that children are inclined to deny aspects of books too remote from what their present knowledge includes, the lower level children who missed letter–sound knowledge did not internalize features of written words (cf. Ehri & Sweet, 1991). A closer look at the differences among high-level children who made progress and those who did not makes plausible that children do not internalize features of written words until they have begun to consider letters to be an important source of information. No children, other than the 7 who read some words on the pretest, learned to read new words as a result of the present interventions. Note that none of these children read in a conventional way when they were pretested. They then succeeded in reading a few words by combining spelling and guessing.

Internalization of textual features did not become apparent in more distant measures such as letter knowledge, rhyming, name writing, and word writing, suggesting that basic skills such as letter–sound associations and phonemic awareness did not improve as an effect of the experiences with P.B. Bear. It is plausible that long-term effects on such measures may occur particularly in the high-level group as a result of these children's attention to the written forms of words that are read to them. Any quantifiable progress in these more distant measures may require an accumulation of book-reading experiences with more books over a longer period.

How Useful Are Electronic Books?

The electronic format is a less efficient means of supporting internalizations of story content. The many attractive options of electronic books seem to divert children's attention from text and number of readings of the text in favor of iconic and pictorial explorations. The present results are not in line with the hypothesis that electronic books stimulate dual processing and thus story understanding (Kamil et al., 2000). Children explored the story about P.B. Bear in bits and pieces by activating animations mostly disconnected from the phrasing of the story. Taking into account that other electronic books may have built-in options that guarantee more dual processing when children explore a story, there is ground for further research into this possible benefit of electronic books. Electronic books such as *Arthur's Birthday* (Brown, 1997) and *The Cat in the Hat* (Seuss, 1997) are designed in a way that animations are more tied up with the reading of text; when children turn a page, the text is read aloud while an animation starts that dramatizes the story.

The present results have shown that in some respects electronic books offer overlapping and complementary experiences to support internalizations of a book's vocabulary and features of the written form of words. In particular, the icons typical of the book used here and some other electronic books (e.g., *The Cat in the Hat*) were attractive and may have elicited internalization of both aspects. When the child clicked on an icon in the rebus-like text, the written word appeared on the screen and was spoken by the computer. In particular, when children have some letter–sound knowledge and have begun to use this knowledge to read words, such experiences may help to extend their word recognition skills. Children ignore the written form when it is too remote from their present knowledge. Similar to other studies in which children's attention was focused on the text (cf. Sulzby, n.d.; Yaden, Smolkin, & MacGillivray, 1993), some children even denied that the text had changed color or form when the examiner directly asked whether they had noticed any changes.

In sum, the expectation that electronic books have the potential to yield reading sessions that in all respects are similar or even more challenging than those with regular books is not confirmed (cf. Labbo & Kuhn, 2000). Exploration of electronic books is not a replacement for regular book-reading sessions but a valuable supplement. Suitable electronic books offer overlapping and complementary experiences with the written form of words and the story content. Combined with nondependence on adult support, electronic books are therefore a useful addition to regular book-reading sessions at home and particularly in kindergarten classrooms.

References

Anderson–Inman, L., & Horney, M. A. (1998). Transforming text for at-risk readers. In D. Reinking, M. C. McKenna, L. D. Labbo, & R. D. Kieffer (Eds.), *Handbook of literacy and technology. Transformations in a post-typographic world* (pp. 15–43). Mahwah, NJ: Erlbaum.

Arnold, D. H., Lonigan, C. J., Whitehurst, G. J., & Epstein, J. N. (1994). Accelerating language development through picture book reading: Replication and extension to a videotape training format. *Journal of Educational Psychology, 86,* 235–243.

Bolter, J. D. (1998). Hypertext and the question of visual literacy. In D. Reinking, M. C. McKenna, L. D. Labbo, & R. D. Kieffer (Eds.), *Handbook of literacy and technology. Transformations in a post-typographic world* (pp. 3–13). Mahwah, NJ: Erlbaum.

Brown, M. (1997). *Arthur's birthday* [CD-ROM]. Novato, CA: Broderbund.

Bus, A. G., & van IJzendoorn, M. H. (1995). Mothers reading to their three-year-olds: The role of mother–child attachment security in becoming literate. *Reading Research Quarterly, 40,* 998–1015.

Bus, A. G., van IJzendoorn, M. H., & Pellegrini, A. D. (1995). Joint book reading makes for success in learning to read: A meta-analysis on intergenerational transmission of literacy. *Review of Educational Research, 65,* 1–21.

Davis, L. (1994a). *P.B. Bear's birthday party*. London: Dorling Kindersley.

Davis, L. (1994b). *P.B. Bear's birthday party* [CD-ROM]. London: Dorling Kindersley, Multimedia.

Davis, L. (1995). *Beestenfeest* [Animal party]. Amsterdam: Zirkoon.

Davis, L. (1996). *P.B. is jarig* [P.B. Bear's birthday] [CD-ROM]. The Netherlands: Bombilla/VNU Interactive Media.

Ehri, L. C., & Sweet, J. (1991). Fingerpoint-reading of memorized text: What enables beginners to process the print? *Reading Research Quarterly, 26,* 442–462.

Greenfield, P. M., Camaioni, L., Ercolani, P., Weiss, L., Lauber, B. A., & Perucchini, P. (1996). Cognitive socialization by computer games in two cultures: Inductive discovery or mastery of an iconic code? In I. E. Sigel (Series Ed.), P.M. Greenfield, & R. R. Cocking (Vol. Eds.), *Advances in applied developmental psychology: Vol. 11. Interacting with video* (pp. 141–167). Norwood, NJ: Ablex.

Greenfield, P. M., & Cocking, R. R. (Eds.). (1996). *Interacting with video*. Norwood, NJ: Ablex.

Hampel, F. R., Ronchetti, E. M., Rousseeuw, P. J., & Stahel, W. A. (1986). *Robust statistics: The approach based on influence functions*. New York: Wiley.

James, R. (1999). Navigating CD-ROMs: An exploration of children reading interactive narratives. *Children's Literature in Education, 30,* 47–63.

Kamil, M. L., Intrator, S. M., & Kim, H. S. (2000). The effects of other technologies on literacy and literacy learning. In M. L. Kamil, P. B. Mosenthal, P. D. Pearson, & R. Barr (Eds.), *Handbook of reading research* (Vol. 3, pp. 771–778). Mahwah, NJ: Erlbaum.

Kozma, R. B. (1991). Learning with media. *Review of Educational Research, 61,* 179–211.

Labbo, L. D., & Kuhn, M. R. (2000). Weaving chains of affect and cognition: A young child's understanding of CD-ROM talking books. *Journal of Literacy Research, 32,* 187–210.

Lancy, D. F., & Hayes, B. L. (1988). Interactive fiction and the reluctant reader. *The English Journal, 77,* 42–46.

Leu, D. J. (2000). Literacy and technology: Deictic consequences for literacy education in an information age. In M. L. Kamil, P. B. Mosenthal, P. D. Pearson, & R. Barr (Eds.), *Handbook of reading research* (Vol. 3, pp. 743–770). Mahwah, NJ: Erlbaum.

Levin, I., & Bus, A. G. (2001). *Does writing evolve from drawing? Young children making notes and mothers' recognition of their notations*. Manuscript submitted for publication.

Lewin, C. (1997). Evaluating talking books: Ascertaining the effectiveness of multiple feedback modes and tutoring techniques. *Forty-Sixth Yearbook of the National Reading Conference,* 360–371.

Lewin, C. (1998). Talking book design: What do practitioners want? *Computers and Education: An International Journal, 30,* 87–94.

Lewin, C. (2000). *Talking book software and beginning to read. Exploring the effects of talking book software in UK primary classrooms*. Unpublished manuscript. (Available from the Open University, Walton Hall, Milton Keynes, United Kingdom)

Marascuilo, L. A., & McSweeny, M. (1977). *Nonparametric and distribution-free methods for the social sciences*. Monterey, CA: Brooks/Cole.

Mason, J., Peterman, C., & Kerr, B. (1989). Reading to kindergarten children. In D. Strickland & L. Morrow (Eds.), *Emerging literacy: Young children learn to read and write* (pp. 52–62). Newark, DE: International Reading Association.

Matthew, K. I. (1996). The impact of CD-ROM storybooks on children's reading comprehension and reading attitude. *Journal of Educational Multimedia and Hypermedia, 5,* 379–394.

McKenna, M. C. (1998). Electronic texts and the transformation of beginning reading. In D. Reinking, M. C. McKenna, L. D. Labbo, & R. D. Kieffer (Eds.), *Handbook of literacy and technology. Transformations in a post-typographic world* (pp. 45–59). Mahwah, NJ: Erlbaum.

Morrow, L. M. (1988). Young children's responses to one-to-one story readings in school settings. *Reading Research Quarterly, 23,* 89–107.

Murray, B. A., Stahl, S. A., & Ivey, M. G. (1996). Developing phoneme awareness through alphabet books. *Reading and Writing: An Interdisciplinary Journal, 8,* 307–322.

Neuman, S. B. (1996). Children engaging in storybook reading: The influence of access to print resources, opportunity, and parental interaction. *Early Childhood Research Quarterly, 11,* 495–514.

Pappas, C. C. (1993). Is narrative "primary"? Some insights from kindergartners' pretend readings of stories and information books. *Journal of Reading Behavior, 25,* 97–129.

Parham, C. (1995). CD-ROM storybooks revisited. *Technology and Learning, 5,* 14–18.

Phillips, G., & McNaughton, S. (1990). The practice of storybook reading to preschool children in mainstream New Zealand families. *Reading Research Quarterly, 25,* 196–212.

Reinking, D. (1994). Electronic literacy. *Perspectives in Reading Research, 4,* 1–7.

Reinking, D. (1997). Me and my hypertext:) A multiple digression analysis of technology and literacy (sic). *The Reading Teacher, 50,* 626–643.

Reinking, D., & Bridwell-Bowles, L. (1991). Computers in reading and writing. In R. Barr, M. L. Kamil, P. Mosenthal, & P. D. Pearson (Eds.), *Handbook of reading research* (Vol. 2, pp. 310–340). New York: Longman.

Scarborough, H. S., & Dobrich, W. (1994). On the efficacy of reading to pre-schoolers. *Developmental Review, 14,* 245–302.

Sénéchal, M., LeFevre, J. A., Thomas, E. M., & Daley, K. E. (1998). Differential effects of home literacy experiences on the development of oral and written language. *Reading Research Quarterly, 33,* 96–116.

Seuss, Dr. (1997). *The cat in the hat* [CD-ROM]. Novato, CA: Broderbund.

Shade, D. D. (1994, Fall). Here we go again: Compact disc technology for young children. *Day Care and Early Education,* 44–47.

Smolkin, L. B., Conlon, A., & Yaden, D. B. (1988). Print salient illustrations in children's picture books: The emergence of written language awareness. *Thirty-Seventh yearbook of the National Reading Conference,* 59–67.

Sulzby, E. (1985). Children's emergent reading of favorite storybooks: A developmental study. *Reading Research Quarterly, 20,* 458–481.

Sulzby, E. (1996). Roles of oral and written language as children approach conventional literacy. In C. Pontecorvo, M. Orsolini, B. Burge, & L. B. Resnick (Eds.), *Early text construction in children* (pp. 25–46). Hillsdale, NJ: Erlbaum.

Sulzby, E. (n.d.). *Part II: Body of the new research: Children's emergent writing during kindergarten and first grade with and without the computer*. Ann Arbor: University of Michigan. (Report to the Office of Educational Research and Improvement, OERI-R117E10021)

Sulzby, E., & Zecker, L. B. (1991). The oral monologue as a form of emergent reading. In A. McCabe & C. Peterson (Eds.), *Developing narrative structure* (pp. 175–213). Hillsdale, NJ: Erlbaum.

Tabachnick, B. G., & Fidell, L. S. (1996). *Using multivariate statistics*. New York: HarperCollins.

Teale, W. H. (1984). Reading to young children: Its significance for literacy development. In H. Goelman, A. A. Oberg, & F. Smith (Eds.), *Awaking to literacy* (pp. 110–130). London: Heinemann.

Teberosky, A., Martí, E., & Garcia-Milà, M. (1998, July). *Early stages in the development of notational knowledge*. Symposium conducted at the XVth biennial meeting of the International Society of Social and Behavioral Development, Berne, Switzerland.

Yaden, D. B., Jr., Smolkin, L. B., & MacGillivray, L. (1993). A psychogenetic perspective on children's understanding about letter associations during alphabet book readings. *Journal of Reading Behavior, 25,* 43–68.

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