

Electronic books versus adult readers: effects on children's emergent literacy as a function of social class

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Abstract

We compared the effects of children's reading of an educational electronic storybook on their emergent literacy with those of being read the same story in its printed version by an adult. We investigated 128 5- to 6-year-old kindergarteners; 64 children from each of two socio-economic status (SES) groups: low (LSES) and middle (MSES). In each group, children were randomly assigned to one of three subgroups. The two intervention groups included three book reading sessions each; children in one group individually read the electronic book; in the second group, the children were read the same printed book by an adult; children in the third group, which served as a control, received the regular kindergarten programme. Pre- and post-intervention emergent literacy measures included vocabulary, word recognition and phonological awareness. Compared with the control group, the children's vocabulary scores in both intervention groups improved following reading activity. Children from both interventions groups and both SES groups showed a similarly good level of story comprehension. In both SES groups, compared with the control group, children's phonological awareness and word recognition did not improve following both reading interventions. Implications for future research and for education are discussed.

Keywords

electronic storybook, emergent literacy, kindergarteners, SES.

The large availability of electronic books (e-books) in the market today poses a novel situation in which kindergarteners can 'read' or listen to storybooks independently. This development holds great promise and makes it imperative to determine how much the use of this new type of software affects young children's language (e.g. vocabulary and story comprehension) and emergent literacy levels (e.g. word recognition and phonological awareness). This comparison is interesting, especially regarding their emergent literacy development, because of the unique features that the storybook software offers which are not available in the printed version.

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Many e-books include different multimedia effects, such as written text, oral reading, oral discourse, animations, music and sound effects. The oral reading of the text by the narrator, accompanied by the highlighted text, can provide users with insights into the nature of the written text by allowing the children to carefully follow the written words, phrases or passages which are being read out to them. Sometimes e-books include optional hidden hot spots which can be activated by the user and which elaborate on the illustrations or the text. Such activity has the potential to expand the children's knowledge of the story events by adding information that does not appear in the original story text. Sometimes clicking on a glowing word of the text might provide the children an explanation of a word, the meaning of which is not yet known to the young child.

Educators and researchers are of the opinion that these various attractive features of the e-book, described above, can possibly be useful as a means for supporting young children's language and literacy development (Labbo & Kuhn 2000; De Jong & Bus 2003; Lefever-Davis & Pearman 2005). It is further believed that exposure to this type of software can be similar to that provided by adult mediation (Dixon-Krauss 1996; Zelermier & Kuzulin 2004) when adults engage in joint book reading with children using hardcover books. Moreover, it could be claimed that the different features available in the software (e.g. following the highlighted text while it is being read, working on phonological awareness) can be even more effective in certain ways than an adult reading to children. For example, Wood (2005) found that the effects of a short intervention with young children (age 5–6) yielded comparable levels of attainment in e-books and adult-based intervention groups. Furthermore, the interactive features of the software appeared to impact on the children's reading strategies in a more effective way than that evidenced by adult support.

Studies which focused on the efficacy of the e-book to support young children's literacy have shown mixed results. For example, it was reported that word recognition skills of school beginners (Miller *et al.* 1994) and of kindergarteners (Lewin 2000; De Jong & Bus 2002) were improved following activity with e-books. E-books were also found to contribute to the enhancement of young children's phonological awareness (Wise *et al.* 1989; Chera & Wood 2003) and their verbal knowledge (Lewin 2000; Segers & Verhoeven 2002). Furthermore, it has been found that good-quality CD-ROM storybooks, which include hot spots that are congruent with and integrated into the content of the story, fostered children's understanding of the storyline (Labbo & Kuhn 2000) and their story-recall ability (Underwood & Underwood 1998).

Yet, it has also been asserted that the same interactive nature of the e-book that creates the potential to support young children's literacy could also be a possible source for distracting the young child from the storyline (Okolo & Hayes 1996; Underwood & Underwood 1998). Labbo and Kuhn (2000) found that incongruence between features in the e-book and the storyline affected the targeted children's passive behaviour and did not support their story understanding. Supporting this notion, Okolo and Hayes claimed that the low com-

prehension levels of poor readers from the second grade using CD-ROM storybooks resulted from inconsistencies between the animations and the storyline in the e-books. Similarly, in another study, fourth graders who read the interactive e-book recalled the story events' structure better than did those who were engaged in the play version of the e-book (Trushell *et al.* 2003).

As young children are usually read to by parents and teachers, it is interesting and important to compare the effect of adults reading a book to the children on the children's language and literacy skills with that of the children reading the book in its digital version independently. For example, De Jong and Bus (2002) found that 4- to 5-year-old children's story comprehension was not as well supported by the electronic version compared with the regular book format read to them by an adult. In line with Labbo and Kuhn (2000), they concluded that 'the many attractive options of e-books seem to divert children's attention from text and number of readings of the text in favour of iconic and pictorial explorations' (p. 154). It was noted that in the printed adult book reading the adults read the complete story to the child six times from beginning to end in each session, while most of the children who read the computer format independently listened to the text only between 1.5 and 2.5 times. Only a small group of children who read the electronic version without games (implemented in the software) heard the story more than once, but at the most two or three times. Labbo and Kuhn's study showed that the iconic facets of e-books have a stronger appeal for children of kindergarten age than does the story text, that more readings of the e-books decrease the listening to the content of the story, and that children with lower levels of literacy focused more on the illustrations than on the text. Children who were more acquainted with the language register were more attracted by the written text. However, progress in word reading occurred only when words were accompanied by icons. Furthermore, skills with more distant features, such as rhyming and phonemic awareness, did not improve between pre- and post-test as a function of the children's experiences with the e-book.

In a more recent study, a comparison was made of the effects on story understanding of the same child being read a printed book by an adult and independently reading an electronic version of the same book (De Jong & Bus 2004). Unlike the findings from their 2002 study,

in this research De Jong and Bus found that both types of reading experiences produced similar effects on children's story comprehension. Trying to explain these results, the researchers noted that the e-book they used in their 2004 study included fewer animations than usually appear in CD-ROM storybooks. Based on two recent content analysis studies of e-books for young children, one in Holland with Dutch e-storybooks (De Jong & Bus 2003) and the second in Israel with Hebrew e-books (Authors 2004), it could be claimed that the software currently available for children aged 3–8 is not very satisfactory as a tool for supporting literacy. In our 2004 study, the 43 Hebrew e-books we examined had limited multimedia features for supporting children's literacy development. For example, only 4.3% had the dictionary option, only 28% allowed the children to follow the text while it was being read to them by the narrator. In addition, 28% included distracting games in the reading mode and used hot spots which were incongruent with the story content.

As researchers who focus on young children's literacy development and who adopt the idea of multiple literacies (Kellener 1998), we concluded that more needs to be done in creating appropriate e-books for young children. We believe that such educational e-books should take advantage of the attractive features of such electronic and interactive media and, at the same time, should serve as a support for children's language development, story understanding and their exploration of the written text. For this reason, we designed an educational e-book in keeping with these ideals. We included three different modes in our CD storybook that children could activate separately: 'Read story only', 'Read story with dictionary' and 'Read story and play'. These modes were developed to foster children's language and emergent literacy growth using principles of amusement as well as educational goals, focusing especially on vocabulary, phonological awareness and text tracking. In keeping with the literature reported above, our software included only a limited number of hot spots in each screen and we designed these hot spots specifically to act as a source of support for the storyline.

The sample of children in this study represented two socio-economic status (SES) communities: low SES (LSES) and middle SES (MSES). Research from various countries has alluded to marked differences between LSES and MSES children's literacy achieve-

ments (Wells 1985; Burgess *et al.* 2002; Authors 2003). Furthermore, there is a rich body of research which supports the notion that the SES gap first emerges as early as the kindergarten level, and which suggests that an important contributory factor to this gap is the relatively poorer home literacy environment typically found in LSES families – for example, a limited availability of literacy tools (e.g. books, educational games) and literacy activities (e.g. frequency of parental book reading to the child), as well as lower levels of parental mediation during such activities (Heath 1983; Aram & Levin 2002). In a recent study in Israel, it was found that LSES children have fewer children's books at home and make fewer trips to the library with their parents. Yet, the majority of the homes visited during the study (95% of the 94 homes) had computers and at least five software items for children.

In the present research, we investigated the extent to which the educational e-book can support children's emergent literacy (vocabulary, phonological awareness, word recognition and story comprehension), compared with children being read the same book in its printed version by an adult, with children from two different SES groups. We posed the following questions: (1) What type of activity, children reading the e-book independently or being read to by an adult, will better improve the child's overall emergent literacy? In which skills might the improvement appear as a function of type of activity? (2) Will there be any difference in the degree of improvement in the children's levels of emergent literacy as a function of their SES group? If yes, in which literacy skills will the improvement appear?

We hypothesized that children in the two reading activity groups (independent e-book reading and adults reading the book to them) will show greater progress in their emergent literacy levels compared with children in the control group who will not participate in either of these reading activities. More specifically, we speculated that children in both intervention groups will progress similarly in their vocabulary skills, but that their phonological awareness and word recognition skills will show greater improvement following independent reading of the e-book because the software has the potential to support these skills. In addition, we hypothesized that LSES children, who are usually less advanced compared with their MSES peers, will benefit more from both interventions (independent e-book reading and adults reading the book to them), compared

with their MSES peers, because of the relatively fewer literacy activities and materials available to them in their homes.

Method

Participants

The sample consisted of 128 children from eight kindergartens; four from LSES ($n = 64$) and four from MSES ($n = 64$) neighbourhoods. From each of the four kindergarten classes in each SES group, 16 children were chosen randomly to participate. The mean age of the children in the sample (in months) was 69.10 ($SD = 3.54$) for the LSES children and 70.30 ($SD = 4.20$) for the MSES children. In this study, SES was defined in terms of the degree of affluence (or poverty) at the neighbourhood level. Neighbourhood SES levels were determined in keeping with The Israel Center Bureau of Statistics (ICBS) (1995) statistical report, which includes such data as number of school years completed, income level, housing density, personal computer ownership and the like.

Children in each of the eight kindergartens were randomly assigned to three different groups. The first group was assigned to work independently on the e-book, the second was read the same book in its printed version by adults, and the third was a control group which was not exposed to this book at all and received only the regular kindergarten programme. In each SES group, 25 children were assigned to the e-book activity, 25 children to the adult book reading activity, and 14 to the control group. Within each SES group, close to equal numbers of boys and girls were represented in each of the three groups. All children who participated in the study had had initial experiences with computers individually and in small groups as part of the curriculum.

The e-book

We based the e-book we designed on the well-known author, Meir Shalev's (1995) 25-page book *The Tractor in the Sand Box* (in Hebrew *Hatractor Beargaz Hachol*). On each page of the book is a big coloured drawing, covering more than half of the page, as well as three to five written sentences of about 40 words. The written text is printed in pointed letters (in Hebrew 'nekudot'), so that children can also relate to the text.

The book's story is about an old farmer (Uncle Aharon) and the special relationship he has with an old tractor. It recounts Uncle Aharon's adventures and his touching relationship with his tractor. The book's story's structure and simple narrative elements: setting, characters, goal/initiating event, problem and solution/ending (Mandler & Johnson 1977) seemed eminently suitable given our participants' ages. When designing the educational e-book based on the hardcover copy of this book, we integrated features that capitalize on the potential of such electronic and e-interactive media to motivate and amuse children, on the one hand, and also included features thought to be supportive for children's emergent literacy and language, on the other.

Main functions of the e-book

The e-book's introductory screen is just like the cover of the hard copy, the book's title and the author's name appearing as they do in the hard copy. An animated figure, that of Uncle Aharon, explains the different options for the activation of the story. The children are offered four modes or options: (1) Read story only, (2) Read story with dictionary, (3) Read story and play and (4) Printing. As mentioned earlier, all activities in the 'Read story and play' mode were presented only after the children had completed reading the text on each page. To keep the text in the e-book as close as possible to that in the hard copy of the book, we scanned the 25 pages from the printed book. Each of the four modes includes an oral reading of the printed text by an actor. The e-book also included automatic dynamic visuals to dramatize story details, fragments and the complete story scene as well as extra music and film effects which helped to transform the e-book into a living book. For example, when uncle Aharon invites the children to join him on a trip to the fields on the tractor's wagon, the children can see the enthusiastic scene and hear the joyful voices of children climbing onto the tractor. The music creates a joyous atmosphere while the vivid objects and characters on the colourful screen are intended to involve the readers at the cognitive level in the events being portrayed. To stimulate the children's reading orientation and involvement in reading, the e-book includes a forward button (a coloured arrow that points to the right) and a backward button (an arrow that points to the left) on each screen, thereby allowing the children to return to previous screens or to continue onto the next one (*note*: in Hebrew, the direction of reading is

from right to left). The children also have available to them a function – clicking on an arrow that repeats the text – which allows them to re-read/re-listen to the text. The highlighting of written phrases as the text is uttered by the actor helps to focus the children's attention on the relationship between text and oral reading, thereby supporting their exposure to written text and, perhaps, their word recognition skills (De Jong & Bus 2002). Also available is an overview screen that presents all optional screens in reduced format; each screen is numbered.

Description of the main modes

The 'Read story only' mode includes an oral reading of the printed text by the actor as well as automatic dynamic visuals that dramatize story scenes, extra music and film effects. The 'Read story with dictionary' mode offers the same oral reading of the text; in addition, this mode presents explanations for difficult words that appear automatically on the screen after the whole page has been read to them by the narrator. As each difficult word appears on the screen (on a big cloud), it is pronounced clearly by the narrator, and is associated with pictures that support its meaning. Initially, the words appear automatically; later, the children have the option to reactivate this function by clicking on the words as often and for as long as they choose.

Although the dictionary mode, which explains the meanings of words, is critical for supporting a rich vocabulary and story understanding, most of the available commercial Israeli and Dutch e-books evaluated by Authors (2004) and De Jong and Bus (2002), as reported above, lacked this function. Based on the recommendations of three judges – two kindergarten teachers and one children's literature expert – regarding their difficulty level for kindergarteners, 12 words from the book were chosen for inclusion in the e-book's dictionary option. In our pilot study we found that the LSES children's knowledge of these words were limited. For this reason and to ensure that the children would be exposed to them, we decided to present the dictionary words automatically the first time around. As the story was 25 pages long and we did not want to overload the children's reading with too much new information, we decided to present only 12 words, about half of which were identified as difficult. The 'Read story and play' mode was designed to enhance the children's story understanding and phonological awareness. Its interactive functions allow the children to activate the story by

clicking on hidden hot spots (represented in the form of a coloured kite) as they appear on (1) characters or objects and (2) words that appear in the text. However, because we did not want the children to be distracted from listening to or reading the story by the hot spots, we programmed it such that the children could activate the hot spots only after reading/listening to the text on each page. The activation of characters or objects in this CD-ROM storybook was designed to enrich story comprehension by such means as including discourse between the main characters as well as voice and sound effects. For instance, just after the scene which presents the different activities that Uncle Aharon and the tractor do together, the narrator reads the text on page 3, saying: 'Uncle Aharon and the tractor worked together.' While the narrator is reading this piece of the text, the children are able to click on a hot spot of the figure of Uncle Aharon, which expands on the text via the following comment by Uncle Aharon: 'The tractor and I are not just ordinary friends, we are friends in body and soul.' The inclusion of hot spots of words was also aimed at promoting children's phonological awareness of syllabic and sub-syllabic levels. For example, when a big flower appears, the word for flower is shown divided into its syllables and sub-syllables while the narrator reads it out aloud.

The 10 words chosen from the book's text for this syllable activity are all common Hebrew words of two syllables (for example, halav ['milk'] is divided into two syllables: *ha-lav*, and into three sub-syllables: *ha-la-v*).

Children's emergent literacy level

Children's emergent literacy level in all three groups was assessed before and after the activity with the e-book using three measures – vocabulary, word recognition and phonological awareness. One measure – story comprehension – was assessed only after the e-book activity with only the two experimental groups.

Vocabulary

Children were asked for the meanings of the 12 words from the book's text which appeared in the dictionary mode of the e-book activity. As described above, these words were judged to be relatively difficult for children of this age and were the most difficult words in the book. Each word was orally presented to the children and

three optional meanings were suggested. The children were asked to choose the best meaning. For example, the children were asked: 'What is the meaning of the word "container" (in Hebrew *meihal*)? (a) Is it a big truck? (b) Is it a big bottle? or (c) Is it a mail box?' Before they were tested, to prepare them for the task, the children were given two examples in which the researchers provided the answer. The total score for this task ranged from 0 to 12. The α score for this measure was 0.63.

Word recognition

The children were asked to read out aloud nine words, each of which appears with a high level of frequency (four to seven times) in the e-book. For each word, scores ranged from 0 to 3 (from high to low), as follows: 3 = correct reading of the word, 2 = partial reading, saying two correct sounds or letters of the word, 1 = limited partial reading, saying one correct sound or letter of the word, and 0 = reading another word or saying 'I don't know'. Thus, the total range of scores for this task is 0–27. Across two raters, the inter-rater reliability for this measure, using Cohen's κ , was 0.80. The α score for this task was 0.92.

Phonological awareness

Phonological awareness was measured using 12 two-syllable words. Six of the words appeared in the target CD-ROM storybook and the other six words were frequently used Hebrew words. The words were orally presented to the children, one at a time, and the children were asked to repeat it in a sub-syllabic way, breaking it into three parts (e.g. the word *gadol* ['big'] should be divided into *ga-do-l*). Each correctly repeated word received a score of 1; incorrect answers were scored 0. Thus, the total range of scores for the 12 words was 0–12. Across two raters, the inter-rater reliability for this measure, using Cohen's κ , was 0.88. It should be noted that although the phonological activity in our e-book software enabled children to work on syllabic and sub-syllabic segmentations, we did not measure children's syllabic skills in this study because Hebrew-speaking children at the age group of those in our study (5–6 years) usually gain high scores on this task.

Story comprehension

Children were asked seven questions related to the e-book they had read as participants in the study, four

dealing with information that appears clearly in the story (e.g. 'What type of work did the tractor do at the beginning of the story?') and three dealing with information that could only be inferred from reading/listening to the story (e.g. 'Why do you think the tractor was sad?'). Each question had four possible answers, which were orally presented to the children, and they were asked to identify the correct one. The total score for this task ranged from 0 to 7. The α score for this measure was 0.62.

Procedure

The pre-intervention stage

The children's emergent literacy levels in three areas – word recognition, vocabulary and phonological awareness – was assessed prior to the e-book activity. As the participants are young, we conducted the tests in two sessions, no more than 5 days apart. In the first session, the children were tested with the 'vocabulary' and 'word recognition' measures; in the second session, the children were tested with the 'phonological awareness' measures. The order of the tests in the sessions was the same for all children. In addition, no more than 3 weeks elapsed between the assessment of the first and the last child in the sample.

The activity with the e-book

The children worked individually with the e-book in three activity sessions and experienced two modes: 'Read story with dictionary' and 'Read story and play'. Each session lasted about 30 min (range 20–35 min). We decided upon only three sessions based on a pilot study using the same e-book which showed that children's (aged 5–6) motivation to work in the same mode decreased significantly after they had done so three times. This was in line with the estimates of De Jong and Bus (2004) and Penno *et al.* (2002) that three to four readings are the ideal number for supporting children's story understanding.

In the first session, children worked on 'Read story with dictionary'; in the second session, they worked on 'Read story and play'; and in the third session, they worked on both modes for about 15 min each. No more than 5 days elapsed between one session and the next. After the participants were shown how the software operates they were given the following general instructions: 'We've brought you a new e-book and you're

invited to work with it. After you finish working with the computer, we'll ask you some questions about the story. That's why we not only want you to look carefully at the pictures, but at the text as well.'

Adult reading to the child

Children were read the printed book by the same adult individually in three activity sessions. The adults were five senior undergraduate third-year students in the school of education. Reading sessions were executed in a strictly prescribed manner. The teacher in the kindergarten introduced the students as teachers and explained that they were going to read them a story. To design a similar reading style that was also ecologically valid, the way the adults read the book to the children was based on the results of a questionnaire administered to 20 kindergarten teachers (in LSES and MSES communities) in which they were asked to describe how they usually read a printed book to the children in kindergarten. Based on the teachers' responses, we created a list of instructions for the adults on how to read the book to the children. The list included four comments the readers were obliged to make, as well as five words and five questions the readers were expected to introduce at specific places during the reading process. (For a similar method used in such research, see De Jong & Bus 2004.) Two of the four comments were made before the book reading started, two of the five questions were asked after the story had been read, and the remaining questions, comments and word meaning were inserted at set points during the reading of the story. For example, one comment was 'You see this is uncle Aharon and this is his tractor'; another was 'Uncle Aharon and the tractor have a very special relationship'. Examples of the questions asked are: 'What do you think the tractor might feel in this situation?' or 'Where do you think the tractor and uncle Aharon are taking the children?' Examples of providing word meaning are: telling the children "'greased" (in Hebrew *garaze*) means to put oil on a tool or a machine' and 'a "container" (in Hebrew *meihal*) is a big bottle'. Both the student-readers and the children sat with the book facing them during the reading activity so that the children could see the text and illustrations throughout the session. All children's questions were answered by the adults, yet the student-readers were told not to elaborate on children's questions so as to ensure that all children received similar treatment and the outlined reading plan

was followed consistently. In addition, regarding the questions that the reader was instructed to ask the children during the reading activity, in all cases, if the children did not answer the questions which were posed or if they gave a wrong answer, the children were told the correct answer.

The post-intervention stage

Following the three-session e-book reading activity, in all three groups, the children's emergent literacy levels were assessed using the same three emergent literacy tasks administered in the pre-intervention phase – word recognition, vocabulary and phonological awareness. In addition, they were administered a fourth measure, a story comprehension test, which was presented only as a post-test to the two experimental groups (the control group was not assessed for story comprehension because they had not read the book). The order in which the three measures were administered during the post-test session was the same as in the pre-test phase; the story comprehension test was administered last. The post-tests were administered 1–4 days after the intervention in both groups, and no more than 3 weeks elapsed between the assessment of the first and the last children in the group.

Results

Preliminary analyses of the pre-intervention overall emergent literacy scores using a two-way multiple analysis of variance (MANOVA) of 2 (SES; low vs. middle) \times 3 (intervention group; e-book reading, adult book reading and control) were conducted first. The means and standard deviations of the children's scores appear in Table 1 (refer to the pre-test columns).

Results showed no significant differences between the pre-test overall emergent literary scores of children in the three groups ($F[8,238] = 0.51$, partial $\eta^2 = 0.01$, $P = \text{ns}$) and no interaction between SES and type of intervention group ($F[8,238] = 1.06$, partial $\eta^2 = 0.03$, $P = \text{ns}$). However, there was a significant difference between children's scores from the two SES groups ($F[4,119] = 20.00$, partial $\eta^2 = 0.40$, $P < 0.001$).

A univariate test with Bonferoni corrections for each of the three pre-test measures of emergent literacy separately showed significant differences for all measures: for vocabulary ($F[1,122] = 14.66$, partial $\eta^2 = 0.11$, $P < 0.001$), for word recognition ($F[1,122] = 41.83$,

Table 1. Children's emergent literacy scores on the pre-test and post-test by group: means and standard deviations.

Measure	E-book reading		Adult book reading		Control	
	Pre	Post	Pre	Post	Pre	Post
Vocabulary	3.90	6.84	3.60	6.50	3.29	3.78
range of scores = 0–12	(2.44)	(3.25)	(2.76)	(3.40)	(2.00)	(3.05)
Word recognition	11.50	14.30	9.74	12.50	10.42	13.42
range of scores = 0–27	(9.88)	(9.37)	(8.90)	(9.77)	(8.01)	(8.87)
Phonological (sub-syllabic) awareness	7.44	8.68	7.06	7.50	7.14	7.89
range of scores = 0–12	(4.63)	(3.93)	(4.49)	(4.42)	(4.48)	(4.47)

Table 2. Children's emergent literacy degree of improvement scores by group and socio-economic status (SES): means and standard deviations.

	Low SES			Middle SES		
	E-book reading	Adult book reading	Control	E-book reading	Adult book reading	Control
Vocabulary	2.60 (2.88)	2.44 (2.36)	0.28 (1.48)	3.28 (2.40)	3.36 (3.09)	1.07 (2.43)
Word recognition	4.92 (5.64)	3.16 (6.40)	3.42 (4.41)	0.68 (3.50)	2.36 (7.59)	2.57 (5.94)
Phonological (sub-syllabic) awareness	2.36 (3.68)	1.32 (3.09)	1.14 (2.62)	0.12 (3.83)	0.44 (3.52)	1.14 (3.03)

partial $\eta^2 = 0.26$, $P < 0.001$), and for phonological (sub-syllabic) awareness ($F[1,122] = 19.63$, partial $\eta^2 = 0.14$, $P < 0.001$).

To determine the effects of the three treatment groups (e-book reading, adult reading of the printed book and control) on the children's emergent literacy achievements, we used repeated-measures MANOVA of *group* by *time* (3×2), with the last variable employed as a repeated-measures variable. The means and standard deviations of the children's pre- and post-test scores appear in Table 1. The findings showed a significant interaction effect for *group* \times *time* ($F[6,246] = 3.62$, partial $\eta^2 = 0.08$, $P < 0.001$).

A univariate test with Bonferroni corrections showed a significant pre- to post-test improvement for the vocabulary measure ($F[2,125] = 10.42$, partial $\eta^2 = 0.14$, $P < 0.001$). In order to determine the source of the *group* \times *time* interaction, a repeated-measures test was executed for each treatment group separately. Results showed a significant pre–post improvement in vocabulary scores for the e-book reading group ($F[1,49] = 61.41$, partial $\eta^2 = 0.56$, $P < 0.001$) and for the adult book reading group of vocabulary ($F[1,49] = 55.00$, partial $\eta^2 = 0.53$, $P < 0.001$), but not for the control group ($F[1,27] = 0.98$, partial $\eta^2 = 0.03$, $P = ns$). Results did not show significant pre–post improvement

in phonological awareness and word recognition scores. As for children's phonological awareness gains following the interaction we made a repeated-measures MANOVA of 3 (group) \times 2 (type of item), namely words from the e-book (e.g. *ha-la-v*) compared with frequent Hebrew words (e.g. *sha-lo-m*). No significant difference was found between groups ($F[1,125] = 0.44$, partial $\eta^2 = 0.00$, $P = ns$) and no interaction ($F[2,125] = 0.22$, partial $\eta^2 = 0.00$, $P = ns$).

Our second question addressed the extent of improvement in children's emergent literacy levels as a function of their SES and intervention group. A two-way MANOVA of 2 SES (LSES vs. MSES) \times 3 groups (e-book reading, adult book reading and control) was performed. The means and standard deviations of the improvement in children's emergent literacy scores in the two SES groups and in each of the three intervention groups appear in Table 2.

A significant difference was found between LSES and MSES children's emergent literacy improvement scores ($F[3,120] = 4.40$, partial $\eta^2 = 0.10$, $P < 0.001$) and a difference between interventions groups ($F[6,240] = 3.73$, partial $\eta^2 = 0.09$, $P < 0.001$); there was no significant interaction between SES and treatment group ($F[6,240] = 0.77$, partial $\eta^2 = 0.02$, $P = ns$).

A test of between-subject effects with Bonferoni corrections for each of the three measures separately showed differences between the two SES groups' scores for vocabulary ($F[1,122] = 4.35$, partial $\eta^2 = 0.03$, $P < 0.05$) and phonological awareness ($F[1,122] = 5.13$, partial $\eta^2 = 0.04$, $P < 0.05$). According to the means presented in Table 2, in vocabulary, the degree of improvement was higher in the MSES group ($M = 3.15$; $SD = 2.74$) than in the LSES group ($M = 2.52$; $SD = 2.72$); conversely, in phonological awareness, the degree of improvement was higher in the LSES group ($M = 1.84$; $SD = 3.38$) than in the MSES group ($M = 0.16$; $SD = 1.67$). It is important to note that the absence of interaction between treatment group (e-book reading, adults reading and control) and SES means that we cannot relate children's progress to the treatment groups.

Regarding the differences between the three intervention groups, the results were similar to those reported above. Differences in degree of improvement appeared only for the vocabulary measure of emergent literacy and only between the e-book reading and the adult book reading groups but not in the control group.

Children's story comprehension was assessed only following the book reading activities using seven questions (range of scores was 0–7). We executed a two-way analysis of variance of 2 (SES; low vs. middle) \times 2 (group; e-book reading, adult book reading) to locate any differences in children's scores on this task. Results showed no significant differences between SES groups (LSES: $M = 5.25$; $SD = 1.59$; MSES: $M = 5.70$; $SD = 1.523$; $F[1,4.56] = 2.13$, $P = ns$) as well as no significant differences between treatment groups (e-book reading: $M = 5.39$; $SD = 1.60$; adult book reading: $M = 5.60$; $SD = 1.64$; $F[1,4.50] = 0.84$, $P = ns$). No significant interaction appeared between intervention group and SES. Children showed an 80% level of success overall in their responses to the seven story comprehension questions.

Discussion

Several studies on children's e-books have shown that there are some potential disadvantages in using this type of software to support children's story comprehension and literacy development (Okolo & Hayes 1996; Underwood & Underwood 1998; Labbo & Kuhn 2000; De Jong & Bus 2002; Authors 2004). In the research

reported here, we presented the children with an educational e-book which was designed specifically to overcome these reported disadvantages. We tested its efficacy for fostering children's emergent literacy in comparison with that of the more familiar context of adults reading the printed version to young children. Our results showed that after working independently with the e-book software for only three sessions, young kindergarteners showed that they had a good understanding of the story's content and that they also were able to learn the meaning of new words which appeared in the story text. These findings supported our expectation that kindergarteners who read the e-book on their own without any adult help and those who are read the printed version of the book by adults would score similarly on their emergent literacy. Moreover, these results held true for children from both the MSES and the LSES groups and for both the children's story comprehension as well as for their acquisition of new words. Over the years, the rich literature on adult-child shared book reading has indicated how important this activity is in supporting children's language and listening comprehension, and how important these skills are, in turn, for reading fluency and comprehension as children grow older (Carlisle & Rice 2002). The results of this study suggest that the beginnings of this process might be enhanced too by the children's independent reading of reading digital books.

We hypothesized that LSES children, who usually are less advanced in their literacy skills compared with their MSES peers, would benefit more than would the MSES children from both reading experiences (adult book reading and e-book). This hypothesis was not supported in our study. Indeed, as expected, LSES children had lower literacy scores in the pre-test on the three measures used – vocabulary, phonological awareness and word recognition compared with the MSES children. In the post-test LSES children showed significant improvement in their phonological awareness skills compared with the MSES children, while the MSES children showed a greater degree of improvement in their vocabulary skills after the intervention. In both cases the improvement appeared in the control group as well.

As the improvement was similar in the control group the change in the children's knowledge could not be related to the treatment in the intervention group. One possible explanation for these results might be that whereas the LSES children's phonological awareness

starts at a lower level compared with that of the MSES children (in the LSES about 40% vs. MSES about 75% success rates on the pre-test), LSES children had a greater opportunity to advance themselves compared with their MSES peers, and this worked in their favour. The improvement in the control group could be related to the exposure to the pre-test itself. The situation was somewhat different regarding their vocabulary skills. Although MSES children knew the meaning of more words than did the LSES children prior to the interventions (MSES 36% vs. LSES 22% success rate on the pre-test), here the MSES children had to go further to show progress than was the case with the phonological awareness task. Indeed, the MSES children were able to learn, on average, the meanings of about three words after the reading activity whereas the LSES children averaged only two words. In this case the improvement in the control group could be related to the exposure to the pre-test itself. In the instance of learning the meaning of words, we can see evidence of the principle that the rich get richer; namely, children who already knew the meaning of more words learned the meaning of more new words during all treatment groups. Yet, this principle worked in the opposite direction in the case of phonological awareness. The LSES children, who tested lower than their MSES peers on phonological awareness during the pre-test, showed a higher degree of improvement than did the MSES children who had started off with higher phonological awareness scores prior to the two reading activities. Possibly, learning the meaning of new words and remembering them is more demanding cognitively than are sub-phonological awareness tasks, a process which was easier for MSES children who were more familiar with this process. No conclusion regarding the efficiency of the e-book we used could be taken from these results, because all treatment groups improved to a similar extent in each SES group. Further research is needed with a larger sample and more reading activities in each intervention group (e-books and adults' reading) in order to learn if and in what way these activities affect children from different SES groups.

Our findings did not show any significant improvement in children's ability to recognize words frequently encountered in the book following either type of reading activity. Although the average degree of improvement was higher in the e-book group ($M = 2.36$, $SD = 3.68$) than in the adult book reading group ($M = 1.32$, $SD =$

3.09), these differences were not significant. As with phonological awareness, it is possible that the children need to be presented with more opportunities while working on the e-book for activating word recognition for the e-book software to show an advantage in this area over the adult book reading activity, which did not focus directly on word recognition.

It is important to note that our software was not specifically aimed at activating the frequently occurring words in the text which were included in the word recognition test, which might explain the lack of significant findings. However, the words they were asked to read in the text appeared between four and seven times in the text; thus, they were actually exposed to these words between 12 and 21 times after the three exposures they were engaged in. Regarding the adult book reading context, it has been observed before that neither parents nor teachers generally emphasize print while reading to children (Dickinson & Tabors 1991), and that children, too, do not focus on print when looking at books (Yaden *et al.* 1993). This might be the case regarding e-books as well and might explain why the children did not show significant progress in word recognition. Similar results appeared in De Jong and Bus's (2002) study when they looked at children's word recognition with no pictures to support the words' meanings. Based on these results, we recommend that e-book software should include an activity that might help the children to learn how key words or repeated words in the book sound and to become familiar with their printed format. The words in the test built into the software could be pronounced in a way which supports the children's ability to build their letter-sound relationships and, thereby, enhances their emergent reading abilities.

It is important to raise some limitations regarding this study. First, we have no data on the mechanisms underlying the process that children engage in when activating this type of educational e-book. Future studies should be designed to better understand the learning processes that the children are involved in while using this type of educational e-book. For example, how much does the children's self-initiated activation – beyond the automatic vocabulary provided by the programme – affect their vocabulary skills? How often do the children on their own initiative activate the phonological hot spots in the 'Read story and play' mode and how does this affect their phonological awareness following the activity? (e.g. see Wood 2005). Second, we tested

the children only at one point after their reading experiences. In the future, we need to look carefully at whether and for how long the children's progress on their literacy skills lasts following each of the two types of intervention – the e-book and adult book reading – by re-testing the effects of these activities after a reasonable period of time. Third, although the α values for word meaning (0.62) and for the story comprehension (0.63) tasks in our study are statistically acceptable (see DeVellis 1991), it still could be considered as low. Thus, caution is needed in the interpretation of the results of this study. The low reliability might be explained by the different levels of items in the test, few were more easy words for the children (like *meihal* which means a big bottle) and others were very difficult (like *lirtom* which means to harness). In future studies more attention is needed to this problem. Generally, the vocabulary test we used was not an easy test for the children; only 54% of the children ($n = 54$) from the intervention groups gained scores above chance level and 7% ($n = 4$) from the control group. This might be explained by the load on the child's memory to remember the three options of answers suggested for each question. A Peabody Picture Vocabulary Test style for vocabulary test could solve this problem in future studies.

To sum up, new technologies have the potential to support cognitive development and learning. The e-book, which is viewed as an authentic reading experience compared with the more traditional drill approach (Labbo & Reinking 1999), could constitute a good source for supporting young children's language development, story comprehension and other emergent literacy skills. How well e-books can do so would depend on their quality and on how well they have been designed to specifically meet the children's developmental needs (Haugland & Wright 1997; Authors 2006). More targeted endeavours in creating and choosing e-books are needed. We need software which, on the one hand, capitalizes on the special advantages of electronic and the interactive media and, and on the other hand, supports children's comprehension of the story and their exploration of the written text.

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