Video storybooks as a bridge to literacy

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The Promise of Multimedia Stories for Kindergarten Children At-risk

Abstract

This research focuses on the ability of book-based animated stories, when well designed and produced, to have positive effects on young viewers' narrative comprehension and language skills. Sixty 5-year olds, learning Dutch as a 2nd language, were randomly assigned to 4 experimental and 2 control conditions. The children profited to some extent from repeated encounters with a storybook with static pictures but more from repeated encounters with the animated form of the story. Both story formats were presented on a computer screen; both included the same oral text spoken in the same voice but the animated story was supplemented with multimedia features (video, sounds, and music) dramatizing the events. Multimedia additions were especially effective for gaining knowledge of implied elements of stories that refer to goals or motives of main characters, and in expanding vocabulary and syntax. The added value of multimedia books was strengthened over sessions. In a group from families with low educational levels who were lagging in language and literacy skills, multimedia storybooks seem to provide a framework for understanding stories and remembering linguistic information.

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Introduction

Multimedia presentations, such as DVDs, computer programs, and television shows, that are based on books and that strictly follow the classic narrative pattern are becoming more popular in the United States (e.g., Arthur, Between the Lions, the Scholastic Video Collection) and the Netherlands (e.g., Mijn Mooiste Prentenboek). An example based on the book Winnie the Witch includes, besides the (spoken) text, live action video, zooms, pans, and sounds and music to dramatize the story. The increasing availability of such animated stories raised our interest in multimedia, and we began to study whether these book-based programs have advantages over traditional storybooks with static pictures (De Jong & Bus, 2002, 2004). This study tests the potential role of new media in the development of narrative comprehension in a group of kindergarten children learning Dutch as a second language.

So far researchers have focused on more traditional activities such as book reading as scaffolds for language and literacy development (e.g., Biemiller, 2003; Feitelson, Goldstein, Iraqi, & Share, 1993). We hypothesize that (spoken) text with static pictures, normally the main source for understanding stories, may not be enough for an emerging comprehension of narratives in groups of young second language learners. Our main purpose was therefore to explore whether additional multimedia features have the potential to play a more significant role in the process of learning to read than encounters with stories with static pictures when young children score at the lower end of language proficiency.

Theoretically it is conceivable that live-action video and other formal features of multimedia books may obstruct the development of narrative comprehension, because they divert attention from the story line and the language, resulting in lower story comprehension and language skills (Hayes, Chemelski, & Birnbaum, 1981). According to this hypothesis the richness of multimedia symbols in multimedia presentations may elicit most attention from young children at the expense of verbal information processing (Hayes & Birnbaum, 1980; Hayes et al., 1981). Evidence gathered so far does not support the notion that young children focus mainly on the nonverbal information and neglect auditory information (Gibbons, Anderson, Smith, Field, & Fischer, 1986). Dutch low socioeconomic status 4- and 5-year-old children in the initial stages of developing story comprehension profited to the same extent from multimedia presentations of a story as from a story including only static pictures read to them by an adult (De Jong & Bus, 2004).

As few, if any, contemporary children live in circumstances that actively exclude a television or computer, most young children have learned how to process film information - the grammar of cut, pans, zooms, and edit - into their final interpretation (Robinson & Mackey, 2003). Thus, rather than detracting from the storyline and story language, video, music, and sounds may expose children to an additional set of processing tools, which in combination with oral text contributes to their ability to interpret events and make inferences (Calvert, Huston, Watkins, & Wright, 1982; Neuman, 1997). In line with Neuman's (1997) theory of *synergy* we therefore hypothesize that additional film representations, music and sounds may add new dimensions to children's knowledge.

Multimedia storybooks may provide a better framework than static picture storybooks for understanding stories and remembering linguistic information from these stories (Lewalter, 2003). Multimedia representations, particularly those commensurate with the events of the story (Beck & McKeown, 2001), may add new content to messages that help children to construct meaning and provide additional means to attain new knowledge about a story. Furthermore, film representations and sounds may add new dimensions to the means that these children employ to attain understanding of the language. In addition to multimedia features as tools to derive the meanings of unknown words, we expect indirect effects through a raised story comprehension that enables children to use contextual cues effectively (Penno, Wilkinson, & Moore, 2002; Jenkins, Stein, & Wysocki, 1984; Nagy, Anderson, & Herman, 1987).

There are various ways to explain the promotion of story and language comprehension via multimedia. One hypothesis is that zoom shots and other visual and auditory effects help focus attention on significant visual details (Calvert et al., 1982; Gibbons et al., 1986). This would suggest that multimedia draw attention selectively to contiguous content, thereby helping the child to select content for processing the story (Greenfield et al., 1996; James, 1999; Kamil, Intrator, & Kim, 2000). As a result, young children's comprehension of stories may go beyond a simple recounting of salient actions as young children are inclined to do (Gibbons et al., 1986) but their retellings may also include aspects that create coherence between story elements.

A second means by which multimedia may aid story and language comprehension is through using nonverbal forms of representation commensurate with verbal representations (Beck & McKeown, 2001; Calvert et al., 1982). Paivio's dual-coding model postulates that the two different classes of information, one specialized for information concerning nonverbal objects and events and the other for dealing with

language, are handled cognitively by separate systems of representation that are structurally and functionally distinct but that may support and expand each other in conveying the same content (Paivio, 1986). The two systems operate independently but interconnections between the two systems trigger activity in the other, thus promoting the creation of coherent mental images of the story (Mayer & Anderson, 1992).

Sharp and colleagues (Sharp et al., 1995) found corroboration for the hypothesis that short stories, accompanied by a helpful video framework, supported 6-year-old children's story recall and interpretation more than stories accompanied by mainly static images. In examining third graders' recall and inferential abilities, Neuman (1989) found that the students who watched a multimedia story recalled more story elements than students exposed to only one medium. However, these results with young children could not be replicated with older and more advanced pupils. Results from Neuman's (1992) study examining the influence of different media presentations on fifth graders' inferences about two mystery stories did not support the hypothesis that multimedia stories supported learning more than "reading" stories. Both media elicited similar story processing strategies.

We hypothesize therefore that older children may have greater imaginative skills and background knowledge, allowing them to reconstruct story images and create verbal representations from text without an additional set of processing tools (Pressley, Cariglia-Bull, Deane, & Schneider, 1987). Multimedia may be profitable especially when print book reading experiences are out of children's reach in traditional verbal settings because children's language proficiency lags behind and there are too many gaps in understanding to fill by guessing at the story meaning and the language (cf. Sharp et al., 1995). In line with this hypothesis, a recent study (Uchikoshi, 2005) found positive relationships between viewing book-based television shows and language and literacy outcomes in groups of kindergarten children learning English as a second language. Our study broadens these findings by contrasting encounters with multimedia stories and stories with static pictures in a group of second-language learners.

Another prediction derived from the literature is that hearing the same story several times, a common practice in daily book reading routines (e.g., Biemiller, 2003), stimulates children to notice more details and to gain a deeper understanding of the story line (Phillips & McNaughton, 1990), and leads to more word learning (e.g., Sénéchal, 1997). Studies support the prediction of a similar effect for multimedia stories (Huston & Wright, 1983; Rice, Huston, & Wright, 1982). Episode repetition on 5 consecutive days was an

effective strategy for enhancing story comprehension in a group of 3- to 5-year-old viewers (Crawley, Anderson, Wilder, Williams, & Santomero, 1999).

At-risk children lagging in language proficiency are thought to especially profit from an accumulation of encounters with the same story presented with multimedia features (Linebarger, Kosanic, Greenwood, & Doku, 2003). Initially incomprehensible stimuli gradually move toward a level of comprehension that makes the multimedia presentation more engaging and that enhances children's capability to acquire new information about the story (Huston & Wright, 1983; Rice et al., 1982). If, in line with our expectations, multimedia indeed result in greater facility to process stories, we expect that an accumulation of experiences with a multimedia story may enhance children's story and language comprehension more than repeated encounters with a static story.

The purpose of this study was to test the following hypotheses: (a) multimedia stories stimulate narrative comprehension more than oral stories with static pictures; (b) effects of multimedia stories go beyond retelling salient story actions but include aspects of a story that are only implied or conveyed orally such as states of mind of main characters; (c) effects of multimedia extends to linguistic skills such as vocabulary and syntax; and (d) repetition stimulates learning but more so with multimedia. These hypotheses refer to kindergarten children with a low proficiency in Dutch because they are assumed to be most receptive to variety in information sources available in children's stories (cf. Sharp et al., 1995).

Method

Subjects

A total of 60 kindergarten children participated in this study. We selected children who were coded at risk for school failure by the school administration in accordance with governmental guidelines: Their parents had a low educational level and they were from immigrant families speaking Turkish, Moroccan-Arabic, or Berber at home. At the start of formal education at the age of 4 these children, like most immigrant children, have had little exposure to Dutch, the language of instruction in preschool and kindergarten classes.

The subjects were selected in three steps:

(1) We contacted inner-city schools in The Hague with at least 80% immigrant children from families with low educational levels according to the school administrations.

(2) With the help of information provided by teachers and school administrations we made a first selection of pupils based on the following criteria: (a) 5 years old; (b) speaking

Turkish, Moroccan-Arabic, or Berber at home; (c) since attending school (the day they reached the age of 4), have been receiving instruction by means of a second language educational program in immersion classes; and (d) no special language impairments or special educational needs.

(3) Next, three selection tests were applied individually to select children according to the following criteria: (a) scoring at the level of the lowest 50% on a language test standardized for Dutch kindergarten children - as is true for most immigrant children, (b) nonverbal intelligence in the normal range, and (c) not familiar with the focal story.

We continued the recruitment process until 60 eligible subjects were found. Although the Turkish and Moroccan populations are the two largest minority groups in the Netherlands (Van Praag, 2003), schools are populated by a wide variety of first languages. Therefore subjects were recruited from 33 kindergarten classrooms in 7 different inner-city schools in The Hague.

Children were randomly assigned to six experimental conditions taking into account a balanced representation of home language, gender, and language proficiency in each of the six conditions. Table 1 presents characteristics of each condition. Per condition (N = 10), half of the selected children spoke Turkish as their first language and half Moroccan-Arabic or Berber, half were boys and half girls, and all children had attended school for more than a year at the time of the experiment. The six groups were similar in age (M = 67.17, SD = 2.91) and on the language test (M = 56.63, SD = 6.01), and scored in the normal range on Raven's Colored Progressive Matrices (average percentile score on Raven's Progressive Matrices: 43.32; SD = 27.47).

Design

Figure 1 presents an overview of the experiment. Sixty children were randomly assigned to one of six conditions and pre- and posttested. The average time between pre- and posttests was 26.6 days (SD = 8.07). The average time between last intervention and first posttest was 5.1 day (SD = 2.16).

Experimental groups. All four experimental groups heard the story about *Winnie the Witch* but there were differences in (a) format (static images vs. multimedia) and (b) frequency of story encounters (1X vs. 4 X). For the four experimental conditions, the number of sessions was equal because children who heard the *Winnie the Witch* story only once played *Midnight Play* in the three other sessions. To keep the time between *Winnie the Witch* and posttesting equal, *Winnie the Witch* was read to the children during the

Table 1 *Characteristics of Subjects per Condition*

	4X Multimedia	4X Static	1X Multimedia	1X Static	Control M[1]	Control	Total
Turkish/Moroccan	5/5	5/5	5/5	5/5	5/5	5/5	30/30
Gender (M/F)	5/5	5/5	5/5	5/5	5/5	5/5	30/30
Number of children with student weighing of 0.9	10	10	10	10	10	10	60
Number of schools/classes[2]	5/8	6/10	5/5	4/9	5/7	4/8	7/33
Age in months (*M*, *SD*)	67.60(2.01)	67.50(3.50)	67.30(2.36)	66.80(3.58)	66.30(3.40)	67.50(2.80)	67.17(2.91)
Months in school (*M*, *SD*)	19.56(2.30)	17.00(5.72)	18.10(3.03)	18.38(4.21)	17.17(4.73)	19.00(4.72)	18.18(4.14)
Raven's Progressive Matrices (Mean percentile scores, *SD*)	34.00(27.33)	33.70(28.76)	42.30(27.54)	43.60(18.55)	61.70(25.44)	44.60(32.35)	43.32(27.47)
Cito Language Test (standardized scores)	56.80(8.16)	57.40(5.32)	57.60(4.58)	56.56(6.39)	55.30(6.17)	56.13(6.16)	56.63(6.01)

Notes.

[1] Control M = control group playing with *Midnight Play*.

[2] Number of different schools/classes from which children were recruited.

fourth session in the 1X conditions.

Control groups. To estimate any effects of special attention and getting extra computer experience we compared a control group that was pre- and posttested only with a second control group that played *Midnight Play* all four sessions.

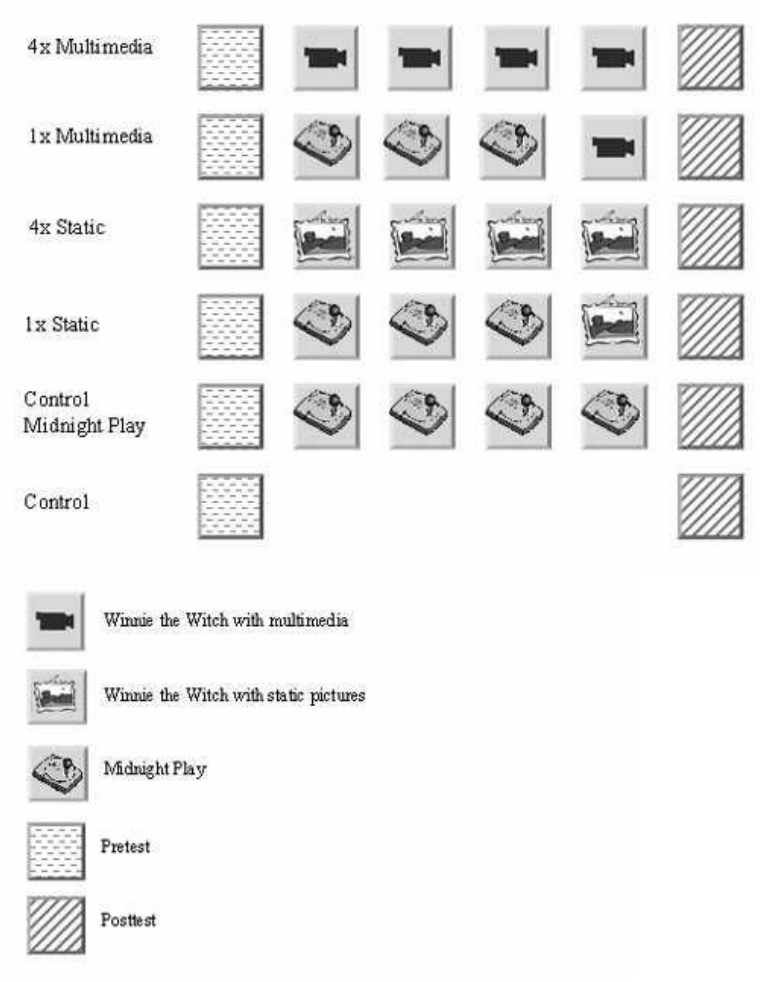

Figure 1. Design.

Procedure

Testing and the treatment sessions took place in a spare room in the school that was not in use for other purposes during the experiment. This room contained a computer installed by the experimenter, a table, two chairs, and a digital video camera in a fixed position.

During regular school hours, the experimenter collected individual children from the classroom and returned each child to his or her classroom when the session was over. The treatment sessions took on average about 6 minutes and pre- and posttesting was spread over several sessions lasting 15–20 minutes. Table 2 presents the duration of the tests and intervention.

The experimenter controlled the computer during Winnie the Witch sessions. With Midnight Play, children were in control of the mouse. The first session began with an instruction, for instance: “I will start the computer and you will hear a story being read to you. While you listen to the story you can look at the pictures on the screen.” When children were distracted from the story or the play during the session the experimenter encouraged the child to look at the screen. There was a general instruction to acknowledge spontaneous comments from the children, but not to dwell on them too long.

All testing and treatment sessions were recorded on video. The experimenter started the camera when entering the room with a child and stopped the camera after the session was completed. During testing and the treatment sessions, a child was recorded from the side to capture the computer screen as well as the child, except for the syntax test where the child was recorded from the front.

Materials Used in the Intervention

Winnie the Witch (Thomas & Gorky, 1996) is a story in Dutch, appropriate for kindergarten children. The length of the story (533 words) and length of the sentences (M = 9.4 words, SD = 4.8) are consistent with other children’s picture storybooks. On the basis of a test to assess children’s familiarity with the book’s vocabulary, we estimated that about 11% of all words in the text were unfamiliar to this sample of children learning Dutch as a second language.

Winnie the Witch, a story with memorable characters and an impressive storyline, includes all components of a well-formed story: a description of characters, setting, time, and activity; events that advance the storyline, including the problem; a termination of complicating events; and an ending.

Both versions, the multimedia and static, have an identical text, are told in the same voice, and both are presented on a computer screen. The only difference is the type of stimulus accompanying the oral text: *static pictures* versus *multimedia* (action video, music, and sounds). The video and sounds generally are related to main aspects of the story such as characters, location, time, problem, goal, story events, resolution, and theme (Labbo & Kuhn, 2000). Insofar animations are noncommensurate, they are small details, such as a floating cup of tea.

Midnight Play (Pacovska´, 2000) is a game composed of a series of unrelated screens, which can be altered by clicking. After a click, movements take place (e.g., a string of balls rolls over the screen), colors change (e.g., the balls turn from blue to red when going from left to right), and music starts or changes with movements or changes of color. There is no spoken language available in this program.

Table 2

Duration of tests and intervention

Selection tests	*CITO Language Test*	50 min
	Raven's Progressive Matrices	15 min
	Familiarity with *Winnie the Witch*	5 min
Pretests	Retelling of *Peace at last* after one reading by the experimenter	10 min
	Vocabulary	10 min
	Sentence repetition	10 min
Intervention	Four sessions (spread over 2 weeks)	4 x 6min
Posttests	Vocabulary	10 min
	Sentence repetition	10 min
	Retelling of *Winnie the Witch* with static pictures	6 min
	Retelling of *Winnie the Witch* with multimedia	6 min

Selection Tests

The *CITO Language Test for Senior Kindergarten Children* (Centraal Instituut voor Toets Ontwikkeling, 1996) was used to assess children's language development.

The Raven Colored Progressive Matrices (Van Bon, 1986) were used to test children's nonverbal intelligence.

To exclude familiarity with the target book, we presented 12 pictures, 6 from well-known picture storybooks including one from the focal story. Per picture, children were asked whether it was from a book, and if so, which book.

Tests to Assess Effects of the Intervention

Retelling of Peace at Last. Preceding the intervention, the children's level of text comprehension was tested by eliciting a retelling of *Peace at Last* by Jill Murphy (1997). After this picture storybook was read once to the child by the experimenter, we elicited a retelling of the story with the help of the pictures. *Peace at Last* has 25 story elements. Some elements are *actions* referring to events expressed with verbs such as "go" or "tick" (e.g., Mister Bear goes to bed, the clock ticks, Mister Bear goes into the garden to sleep) while *implied* elements are states of mind mainly referring to goals or motives of main characters expressed with verbs such as "see," "decide," "think," or "is furious." Three independent coders agreed substantially (average kappa: .81) with the authors' assignments to actions (13 elements) or implied elements (12 elements).

Retellings of Winnie the Witch. After the intervention, children were posttested by eliciting a retelling of *Winnie the Witch*. They retold this story twice, once prompted by the static screens and once by the animated pictures on the screen with the sound turned off. The order, starting with the static or multimedia version, was counterbalanced per condition. With the multimedia version, the experimenter stopped the animated pictures at the same point in the story as was done in the static version. The experimenter accessed the next screen/section of the video when the child indicated he or she had finished retelling that section of the story, thus having ample opportunity to tell the story at his or her own pace.

The narrative was divided into story elements that the authors assigned to actions (11 elements) or implied elements (6 elements). Two independent coders agreed substantially with the authors' assignments (average kappa: .70). All actions and implied elements are listed in Table 3.

Contrasting the retelling by means of animated with the retelling by means of static pictures with the use of multivariate analysis of variance, we found no significant main effect for test type. We therefore combined the scores per element.

Table 3

Actions and Implied Story elements in Winnie the Witch

implied	The house is black and the cat is black.
implied	*Winnie* often doesn't see the black cat.
action	*Winnie* falls again.
implied	*Winnie* decides that something has to be done.
action	*Winnie* changes *Wilbur* into a green cat.
action	*Wilbur* sleeps on the chair, on the floor and on the bed.
action	*Wilbur* is put outside on the grass.
action	*Winnie* stumbles over Wilbur in the green grass.
implied	*Winnie* is furious.
action	*Winnie* changes *Wilbur* into all the colours of the rainbow.
action	*Wilbur* crawls into the grass.
action	*Wilbur* hides in the highest tree.
implied	*Winnie* worries about *Wilbur*.
action	*Winnie* magically makes *Wilbur* black again.
action	*Wilbur* comes out of the tree.
action	*Winnie* transforms the house into all colours.
implied	*Winnie* can see *Wilbur* wherever he is.

Expressive vocabulary was pre- and posttested with 42 content words from the *Winnie the Witch* story. Children filled in the last word of a sentence that the experimenter orally presented while the children saw a matching picture, for instance, "the cat lies on the... (floor)" with a picture of a cat lying on the floor. The selected words have a low representation in a corpus of picture storybook language and instructional language aimed at 4- and 5-year-olds (Schrooten & Vermeer, 1994). This set included nouns (*heks*-witch; *Helmer*-*Wilbur*; *rozenstruik*-rosebush*; poten*-legs*; gras*-grass; *tapijt*-carpet; *dag*-day; *nacht*-night), adjectives (*snorrend*-purring; *woedend*-furious), and verbs (*struikelen*-stumble; *deed*-put; *zat*-sat; *zwaaien*-wave). Forty words remained after exclusion of two words (*witch* and *grass*) that were known by the majority of the children (80% or more) at the pretest.

Syntax was pre- and posttested by having children repeat a selection of sentences from the text of *Winnie the Witch.* As children begin to understand the grammar of sentences better, they make fewer mistakes in repeating these sentences (Droop & Verhoeven, 2003). There were 24 sentences with an average length of 8–9 words per sentence (*SD* = 2.57). We scored the number of correctly repeated words per sentence. By

selecting the longer sentences (4 words or more) we could be confident that success was not due to short-term memory only.

Two independent coders blind to the experimental condition of the subjects coded all tests. They coded children's responses directly from videotape. The interrater reliabilities and alpha reliabilities were satisfactory; see Table 4.

Table 4

Number of Items, Inter-rater reliabilities, and Alpha reliabilities per Scale

	Scale	Number of items	Intercoder reliability (*r*)	Alpha-reliability
Peace at last	All elements	25	.91	.81
	Actions	13	.99	.78
	Implied	12	.64	.70
Winnie the Witch	Multimedia	17	.94	.88
Winnie the Witch	Static	17	.94	.85
Winnie the Witch (combined[a])	All elements	17	.94	.93
	Actions	11	.94	.89
	Implied	6	.81	.68
Vocabulary	Pre-test	40	.89	.55
	Post-test	40	.89	.76
Syntax	Pre-test	24	.98	.93
	Post-test	24	.98	.94

Note. [a] Per element scores of static and multimedia stimuli were combined.

Statistical Analyses

We tested our research hypotheses via ANCOVAs. To reduce the error term and to obtain a more precise estimate of the treatment effects, dependent measures were adjusted for individual differences in covariates (Keppel & Wickens, 2004). For instance, analyzing effects on vocabulary (posttest) the covariate was the pretest score on vocabulary. We expected that: (a) experimental groups would score better than the control groups; (b) the multimedia groups would score better than the static groups; (c) four encounters were better than one encounter; and (d) as a result of repetition, the multimedia group would have a higher increase in score than the static group. To test these hypotheses we carried out a series of planned comparisons. Nine of the total 15 pairwise comparisons were

therefore examined: (a) *Midnight Play* as the baseline control condition versus the no-treatment control condition (thus tracking down nonspecific intervention effects that result from raised attention or computer experience); (b) each experimental condition versus the (baseline) control condition; (c) multimedia versus static condition, after one and after four story encounters; and (d) one encounter versus four encounters, in the static and multimedia condition. As a set, the comparisons were not mutually orthogonal but the fact that each comparison tested for a part of the expected pattern overrides the need for orthogonality (Keppel & Wickens, 2004). Type I error rate was controlled by subjecting comparisons to familywise error correction applying the Ŝidák-Bonferroni procedure (Keppel & Wickens, 2004). With nine comparisons at the $\alpha = .05$ level and directional tests (because a predicted pattern includes specific directionality), the individual tests were evaluated at the 1.164% level (Levin & Neumann, 1999). Assumptions of normality of sampling distributions, linearity, homogeneity of variance, homogeneity of regression, and reliability of covariates were evaluated.

Results

Differences Between Experimental Groups

A series of omnibus *F* tests did not reveal statistical significant differences in age, number of months at school, language proficiency, and intelligence-variables that could influence the effects of the intervention. See Table 1 for average scores and standard deviations. According to a series of ANOVAs with ethnicity (Moroccan vs. Turkish) or gender as independent variables, pre- and posttest scores on story comprehension, vocabulary, and syntax (pre- and posttests) revealed no significant omnibus *F*s. Therefore we did not include ethnic background or gender as an independent variable in further analyses.

Effects on Story Understanding

Visual inspection of total number of elements in the retellings of *Winnie the Witch* revealed a pattern highly consistent with the expectation that story comprehension improved in all experimental conditions but more in the multimedia than in the static conditions and more with repetition; see Figure 2 and Table 5. More important, the test results supported the predicted pattern. After adjustment by the covariate (the pretest score on *Peace at Last*), $F\ (1, 53) = 41.70$, $p < .001$, $\eta^2 = .44$, we tested effects of experimental conditions compared to the baseline control group. The scores after one encounter with the

static book did not exceed those of the control group whereas scores did exceed the control group after 4 X multimedia (F (1, 53) = 55.79, $p < .001$, $\eta^2 = .51$), 4 X static (F (1, 53) = 22.43, $p < .001$, $\eta^2 = .30$) and 1 X multimedia (F (1, 53) = 9.93, $p < .003$, $\eta^2 = .16$). In the static, F (1, 53) = 9.88, $p < .003$, $\eta^2 = .16$, and in the multimedia condition, F (1, 53) = 18.65, $p < .001$, $\eta^2 = .26$, scores improved as a result of repeated encounters with the story. However, scores improved more in the multimedia condition than in the static condition as indicated by significantly higher scores for multimedia after four encounters, F (1, 53) = 7.47, $p < .009$, $\eta^2 = .12$. The multimedia book revealed higher scores than the static book after one encounter, but the difference was then not statistically significant. As the two control groups did not differ from each other it is not plausible that growth resulted from anything other than story encounters.

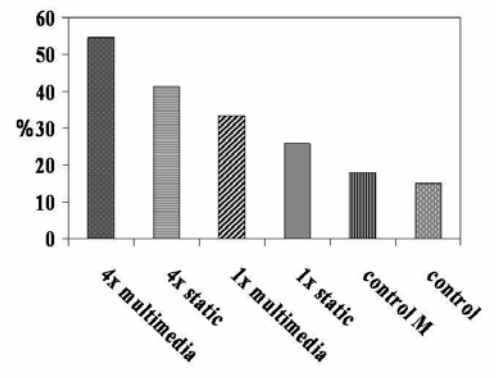

Figure 2. Percentage of Story elements coming back in Children's Retellings per Condition.

Did Story Understanding Broaden as a Result of Multimedia?

The present data support the hypothesis that for young children, actions are easier to grasp than implied elements. Actions in *Winnie the Witch* (M = 40.17%, SD = 23.84) revealed higher scores than implied elements (M = 14.94%, SD = 15.15), F (1, 59) = 143.66, p <.001, $\eta^2 = .71$. Likewise, for *Peace at Last* scores on actions (M = 42.22%, SD = 23.67) were significantly higher than scores on implied elements (M = 34.04%, SD = 21.28), F (1, 59) = 6.66, p<.012, $\eta^2 = .10$.

Table 5 *Mean Scores on Story Comprehension, Vocabulary, and Syntax in percentages per condition*

	4x Multimedia	4x Static	1x Multimedia	1x Static	Control M	Control	Total
Story comprehension							
Pre-test	39.43(15.63)	34.33(13.47)	42.60(28.92)	43.67(12.52)	27.87(21.05)	41.87(16.74)	38.29(18.93)
Post-test	55.00(13.16)	39.12(13.01)	35.59(21.89)	28.55(15.37)	12.79(10.49)	16.91(8.86)	31.33(19.83)
Adjusted[a]	54.43(10.89)	41.12(10.93)	33.41(10.94)	25.83(10.96)	18.07(11.18)	15.10(10.92)	31.33(10.97)
Vocabulary:							
Pre-test	12.50(6.97)	10.75(6.46)	13.25(6.46)	9.75(5.33)	8.25(5.14)	8.50(4.12)	10.50(5.89)
Post-test	28.13(8.92)	18.25 (8.74)	20.50(9.56)	15.00(7.45)	10.75(6.78)	15.25(7.86)	17.98(9.63)
Adjusted[a]	26.02(5.65)	17.99(5.59)	17.60(5.70)	15.79(5.60)	13.12(5.66)	17.36(5.65)	17.98(5.64)
Syntax:							
Pre-test	57.36(11.44)	56.51(15.45)	63.19(16.24)	58.21(10.98)	55.85(13.87)	50.00(13.53)	56.85(13.70)
Post-test	70.09(8.87)	63.21(18.88)	70.85(14.48)	63.21(8.14)	58.96(13.72)	57.69(12.84)	64.00(13.71)
Adjusted[a]	69.65(5.58)	63.51(5.58)	65.26(5.69)	62.01(5.58)	59.85(5.58)	63.74(5.71)	64.00(5.62)

[a] post-test scores adjusted for pre-test scores.

Table 6 *Mean Scores on Actions and Implied Elements in percentages per condition*

	4x Multimedia	4x Static	1x Multimedia	1x Static	Control M	Control	Total
Actions:							
Pre-test	49.60(14.50)	37.56(22.39)	39.62(34.66)	47.05(17.59)	32.05(25.63)	47.44(23.01)	42.22(23.67)
Post-test	66.82(12.13)	50.91(16.04)	46.14(27.65)	35.78(19.08)	16.82(14.14)	24.55(11.78)	40.17(23.84)
Adjusted[a]	63.35(13.90)	53.10(13.83)	47.36(13.80)	33.51(13.83)	21.60(14.01)	22.09(13.84)	40.17(13.87)
Implied elements:							
Pre-test	28.42(20.13)	30.83(22.92)	45.83(26.43)	40.00(17.92)	23.33(17.48)	35.83(18.45)	34.04(21.28)
Post-test	32.25(19.17)	17.50(10.54)	16.25(15.65)	15.28(10.21)	5.42(5.57)	2.92(6.53)	14.94(15.15)
Adjusted[a]	33.71(11.17)	18.34(11.12)	13.18(11.43)	13.73(11.18)	8.20(11.37)	2.45(11.11)	14.94(11.23)

[a] post-test scores adjusted for pre-test scores.

Note: Because the pre-test story (*Peace at Last*) was easier than *Winnie the Witch* pre-test scores are sometimes higher than post-test scores.

Multimedia particularly affect recall of implied elements; see Table 6. After adjustment of scores on implied elements in *Winnie the Witch* by the covariate (implied elements in *Peace at Last*), F (1, 53) = 12.84, $p < .001$, $\eta^2 = .20$, 4 X multimedia revealed higher scores than the baseline control condition, F (1, 53) = 26.41, $p < .001$, $\eta^2 = .33$. Other contrasts with the control condition were not statistically significant, nor was the difference between the two control conditions. Scores improved as a result of repeated encounters in the multimedia condition, F (1, 53) = 17.11, $p < .001$, $\eta^2 = .24$, but not in the static condition. The multimedia condition improved more as a result of an accumulation of encounters with *Winnie the Witch*, as appears from a significant difference between the static and multimedia condition after four times, F (1, 53) = 9.60, $p < .003$, $\eta^2 = .15$.

By contrast, actions revealed a very similar pattern in the static and multimedia condition; see Table 6. Posttest scores on action elements in the experimental conditions adjusted for *Peace at Last* (F (1, 53) = 35.68, $p < .001$, $\eta^2 = .40$) exceeded the baseline condition, after 4 X multimedia, F (1, 53) = 45.88, $p < .001$, $\eta^2 = .46$, after 4 X static, F (1, 53) = 26.12, $p < .001$, $\eta^2 = .33$, after 1 X multimedia, F (1, 53) = 17.47, $p < .001$, $\eta^2 = .25$, and marginally after 1 X static, F (1, 53) = 3.74, $p < .063$, $\eta^2 = .07$. The two control conditions revealed similar scores. Scores improved as a result of repetition as appears from a statistically significant contrast between 1 X and 4 X in the static condition, F (1, 53) = 10.10, $p < .003$, $\eta^2 = .16$, and a marginally significant contrast in the multimedia condition, F (1, 53) = 6.73, $p < .013$, $\eta^2 = .11$, but not as an effect of format (multimedia versus static).

Effects on Linguistic Skills

Effects on vocabulary and syntax were tested separately from story understanding and each other as inter-correlations were only moderate. Mean correlation coefficients for the pre- and post-tests were .56 and .61, respectively.

Vocabulary increased in the multimedia condition but not in the static condition; see Table 5. After adjustment by the covariate (the pretest score on *vocabulary*), F (1, 53) = 65.39, $p < .001$, $\eta^2 = .55$, the 4X-multimedia condition revealed higher scores than the baseline control condition, F (1, 53) = 26.63, $p < .001$, $\eta^2 = .33$, but none of the other experimental conditions differed statistically significantly from the baseline, nor was the difference between the two control conditions significant. Four times revealed higher scores than one time in the multimedia condition, F (1, 53) = 11.35, $p < .001$, $\eta^2 = .18$, but not in the static condition. The multimedia condition revealed a higher score than the static

condition after four story encounters, F (1, 53) = 10.33, $p < .002$, $\eta^2 = .16$, but not after one encounter.

The outcomes for syntax were similar but less pronounced; see Table 5. After adjustment by the covariate (the pretest score on *syntax*), F (1, 53) = 254.54, $p < .001$, $\eta^2 = .83$, only 4 X multimedia exceeded the baseline control condition, F (1, 53) = 15.42, $p < .001$, $\eta^2 = .23$. There were no differences between the two control conditions. Repeated encounters did not reveal effects, neither in the static nor in the multimedia condition. The multimedia condition revealed a marginally higher score than the static condition after four story encounters, F (1, 53) = 6.05, $p < .017$, $\eta^2 = .10$.

Discussion

In a young group at risk for school failure the availability of new dimensions created by presenting a story with rich images, music, and sounds promotes story understanding. Five-year-olds learning Dutch as a second language profited to some extent from repeated encounters with a book with static pictures but less so than from repeated encounters with the multimedia version of exactly the same story. After hearing the oral narration four times while looking at static pictures on the screen—a condition that seems analogous to print-book reading sessions— children understand only part of the story. After four readings, children's retellings are far from complete and include on average 39.12% of the story elements (*SD* = 13.01). When video, sounds, music, and oral text are combined in the multimedia storybook, children at risk seem to profit more from such repeated story experiences as is indicated by the more complete retellings after four encounters. In the 4X multimedia condition, children's retellings covered on average 55% of all story elements (*SD* = 13.16). In line with Neuman's (1997) theory of synergy, extra nonverbal features including video, music, and sounds seem to function additively when children are making inferences about a story's structure and when abstracting the story line.

Another striking result is that multimedia additions are particularly effective at improving young children's awareness of implied elements that refer to causal and enabling relationships between groups of events. The outcomes support the hypothesis that young children best recall salient actions that are clearly visualized by pictures or an action movie (cf. Gibbons et al., 1986) and that they do less well on implied story elements. After an intervention with only static pictures available, children's retellings consist mainly of a series of actions mostly leaving implied elements out of their retelling. Children

understand that *Winnie the Witch* keeps stumbling over the cat (action) and that she changes the cat into a green cat (action) but they do not mention the fact that *Winnie the Witch* gets angry when she has fallen once again and decides to do something about it (implied). Retellings of a story after 4X multimedia, on the contrary, do not just contain actions but implied elements as well. These children also named states of minds of main characters ("sees," "is furious," or "decides"). In other words, multimedia may make children more sensitive to the importance of the goals and intentions of the protagonists although we cannot be certain that children indeed understand how those implied elements set a train of action in the story in motion. Recall of these implied elements might be a first step in understanding the coherence of a story.

The outcomes are in line with the hypothesis that having a detailed nonverbal frame of reference might be particularly important for drawing attention selectively to contiguous content, thereby aiding the child in the selection of content for processing the story (Gibbons et al., 1986). The results also open up the possibility that nonverbal symbols stimulate what good readers spontaneously do, namely transforming information in a text into mental images that include visual-spatial information about a story, thus making information more memorable (Kamil et al., 2000). The results are consistent with Paivio's (1986) hypothesis that a nonverbal representation triggers questions about the events and activates inferencing skills, thus stimulating more in-depth story understanding.

A third striking result is that children's language skills improved considerably more after repeated encounters with the multimedia story than after encounters with the static version. Children may learn some new words or sentence structures from direct referential connections between word/sentence and image but learning this way may be an exception to the rule. It is rare for just one thing to be happening on the screen. Most of the time, many things happen simultaneously. Our results are in line with the hypothesis that a context supportive of story understanding facilitates the acquisition of new vocabulary and sentence structures. When children understand more of the story, they are better equipped to derive the meaning of unknown words and sentences and more able to extract this new knowledge from memory afterward.

The gain in vocabulary after listening four times to *Winnie the Witch* with multimedia (15.75%) is similar to average gain scores of 19.95% for kindergarten children in Biemiller's (2003) experiment and 12.68% to 25.05% for first-grade students in Brabham and Lynch-Brown's experiment (2002). In these two experiments, both testing receptive vocabulary, books were read three to four times and words were explained

shortly before, during, or after reading (e.g., “It seemed like a good solution. What does solution mean? The solution is the answer to a problem.”). Multimedia seem to compensate for such interactions about words during or after book reading. Contrary to the two aforementioned studies, new vocabulary was not explicitly practiced in this experiment. The effect in the present study is even more remarkable when we consider that a text such as *Winnie the Witch* is less suitable to derive the meaning of unknown words as a consequence of the high proportion of unknown words (Swanborn & de Glopper, 1999). Note also that these learning effects occurred in a relatively short period (in all children spent 24 minutes on *Winnie the Witch*).

Positive effects of multimedia accumulate with repeated exposures. After one encounter with a book that includes video, music, and sound effects, children are able to retell somewhat more events (35.59%, *SD* = 21.89) than after one encounter with just static pictures (28.55%, *SD* = 15.37) but this difference was not statistically significant. However, with repeated encounters, differences between the two conditions increased, and what matters more is that after four encounters the multimedia group, in contrast to the static group, included implied elements in their retellings and had gained more in linguistic skills. Assuming a structural-functional relationship between nonverbal and verbal representations (Paivio, 1986), this accumulation of effects seems a plausible outcome. A better understanding of nonverbal objects and events may enable children to find out more of the story language in follow-up sessions and complete the verbal representation. A raised level of understanding of the language may trigger better understanding of nonverbal objects and events in turn, thus enabling them to construct a more coherent representation of the story events in follow-up sessions.

In other words, the benefit gained from multimedia accumulates each subsequent session. For the time being we can only guess what the optimal frequency will be. Leung and Pikulski (1990) reported that children with good language skills were getting bored by the third reading but that presumably does not apply to children at the lower levels of language proficiency. Taking into account that the children in this study could retell at most approximately half of the story elements after hearing the story four times it might take more repetitions before children actually get bored and lose attention. We speculate that a ceiling effect cannot be excluded and perhaps that repetition more than four times would not increase their understanding beyond a certain level.

Limitations and Future Directions

The present findings do not imply that all 5-year-olds benefit from multimedia to the same extent. This study included at-risk children lagging in understanding the language of picture storybooks in a second language. Children who are more advanced in language and literacy skills may have greater listening and imaginative skills, allowing them to process oral text alone more adequately and to expand their syntax and vocabulary without the availability of nonverbal information sources (Pressley et al., 1987).

Another limitation of the present study is that we based our conclusions on one single story. The quality of multimedia may vary, resulting in more positive or negative outcomes with other stories. On the other hand, there is no reason to assume that the story about *Winnie the Witch* deviates strongly from other picture storybooks for this age range. An inquiry among the teachers in the 33 classes, from which we recruited our subjects, produced a series of picture storybooks of similar length and complexity.

Note also that the book-reading conditions were not wholly representative of reading aloud at home or in school. Besides various sources of information (the spoken text and the static pictures or action movie, sounds, and music) there was no support in the form of questions or comments by the parent or teacher as is normally part of reading to children. Perhaps explaining some of the events would have yielded more effect, especially if questions and comments had been tailored to the needs of the child (cf. Brabham & Lynch-Brown, 2002; Dickinson & Smith, 1994).

Furthermore, viewing animated book-based programs at home can be very different from the one-to-one sessions in this study and we cannot generalize beyond this particular context.

Conclusion, Speculations, and Recommendations

A unique result of this study is that the new processing tools have advantages that extend beyond static pictures, which give only a random indication of story events, and that seem to compensate for a high percentage of unknown words. This study provides strong support to the theory of synergy that claims that new dimensions of screen media (video, music, and sounds) contribute to children's ability to recall story elements. Or, more precisely, in a group with limited linguistic luggage new processing tools help to convey content instead of diverting attention from the story or the language. We hypothesize that children who have limited proficiency in the language of the school—a situation that is becoming more and more common all over the world—need the intensity

of a synergistic intervention as they have fewer background experiences to help them understand the story line and derive the meaning of unfamiliar words and sentences. Well-designed book-based programs on television and Internet sites that include multimedia might be a great way of promoting at-risk children's story understanding and linguistic skills. Note, however, that the availability of multimedia in itself does not qualify television and Internet sites as the proper tools through which to promote language and literacy skills. Even when children spend a great deal of time watching television, they may still miss the "good" programs.

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