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## **Video Storybook Reading as a Remedy for Vocabulary Deficits**

### **Outcomes and Processes**

#### **Abstract**

*A substantial percentage of the kindergarten population in the Netherlands lags so far behind in L2 proficiency that they may hardly profit from picture storybook reading promoted as a remedy for vocabulary deficits. The first aim of this study was to test whether young children with limited proficiency in their second language benefit more from repeated readings of a digitized storybook that includes video instead of merely static illustrations. Subjects (N = 106) were randomly assigned to a control condition or one of four treatment conditions crossing two levels of repetition (one or four exposures) with two versions of the same story (merely static pictures vs., instead of pictures, video representations). A second aim was to test the hypothesis that video storybooks promote the acquisition of new language because children are more inclined to sustain their efforts to extract meaning from the text when video is added. As indicator of the amount of mental effort, skin conductance was monitored in a sub-group that encountered the same story four times (N = 42). The results support the hypothesis that video storybooks offer a suitable framework for vocabulary acquisition in kindergarten children with low L2 proficiency. Furthermore, mental effort remains at a higher level when a video storybook is repeated and this stability is one of the generating mechanisms through which video storybooks are more effective than static storybooks at stimulating L2 vocabulary.*

#### **Keywords**

*storybook reading, video storybooks, vocabulary, mental effort, repeated readings, psychophysiology, children at-risk, L2 proficiency.*

## **Das Lesen von Video Storybooks als Hilfe bei Wortschatzdefiziten**

### **Empirische Resultate und mentale Prozesse**

#### **Zusammenfassung**

*Ein erheblicher Prozentsatz der Kinder in niederländischen Kindergärten hat einen so erheblichen Rückstand in der Zweitsprachkompetenz, dass sie kaum von dem als Mittel gegen Vokabeldefizite gepriesenen Lesen von Kinderbüchern profitieren können. Das erste Forschungsziel dieser Studie war zu testen, ob junge Kinder mit eingeschränkter Zweitsprachkompetenz von einem wiederholten Lesen digitaler Geschichten mit integ-*

rierten Videosequenzen mehr profitieren als vom Lesen digitaler Geschichten mit statischen Abbildungen. Die Versuchsteilnehmer ( $n = 106$ ) wurden im Zufallsverfahren der Kontrollbedingung oder einem von vier Experimentalbedingungen zugewiesen, die sich als gekreuztes Studiendesign mit zwei verschiedenen Stufen des wiederholten Lesens (eine oder vier Wiederholungen) und zwei verschiedenen Versionen derselben Geschichte (statische Abbildungen oder Videosequenzen) ergaben. Als zweites Ziel der Studie wurde die Hypothese getestet, ob Video Storybooks den Zweitspracherwerb dadurch fördern, dass die Kinder ihre Bereitschaft zum sinnentnehmenden Lesen länger aufrecht erhalten, wenn dem Text Videofunktionen hinzugefügt werden. Als Indikator für den Grad an geistiger Anstrengung wurde in einer Substichprobe von Kindern ( $n = 42$ ), die dieselbe Geschichte viermal lasen, der Hautleitwert gemessen. Die Ergebnisse stützen die Hypothese dass Video Storybooks einen geeigneten Rahmen für den Wortschatzerwerb von Kinderkartenkindern mit geringer Zweitsprachkompetenz bieten. Zusätzlich zeigte sich, dass die geistige Anstrengung auf einem höheren Niveau blieb, wenn ein Video Storybook wiederholt gelesen wurde. Diese Stabilität ist einer der generativen Mechanismen durch den Video Storybooks den Wortschatzerwerb in der Zweitsprache stärker stimulieren als Geschichten mit statischen Abbildungen.

### Schlagworte

*Geschichten lesen, Video Storybook, Wortschatz, geistige Anstrengung, wiederholtes Lesen, Psychophysiologie, Risikoschüler, Zweitsprachkompetenz*

## Introduction

In the Netherlands, about 18% of all primary-school children lag behind in the language of teaching (Central Bureau of Statistics, 2008). These children mainly come from low-educated immigrant families (CBS, 2008). Children from parents who immigrated to the Netherlands from less developed non-European countries, such as Turkey and Morocco, especially do not profit to the same extent from education as other groups, even in the second generation (Heath, Rotheron, & Kilpi, 2008). This situation may be because a serious vocabulary lag in their first as well as their second language at the start of school (Leseman, Mayo, & Scheele, 2009) puts them at great risk for reading failure (Juel, 2006). As a result, many early childhood educational programs focus on language and literacy, promoting storybook reading as an educational tool to enhance second-language acquisition (Broekhof, 2006; Stolwijk & Peters, 2006).

Most educationalists consider it essential that children become familiar with the type of language used in books, as this form of discourse is most common in academic texts (Anderson, Anderson, Lynch, & Shapiro, 2003; Delpit, 1995). In Dutch kindergartens, children are read to on a daily basis or even several times a day (Blok, 1999). The favorable effect on language, in particular on vocabulary, so often found in storybook reading research with L1 learners (Bus, 2001; Bus, van IJzendoorn, & Pellegrini, 1995; Frijters, Barron, & Brunello, 2000; Sénéchal, LeFevre, Thomas, & Daley, 1998) might be non-existent, or at least more modest,

in L2 learners. There is some evidence that the beneficial effect of storybook reading on first-language vocabulary is the same for second-language learners (Collins, 2005); however, Garcia and Godina (1994) found that young children learning English as their second language were not attentive at all when an English storybook was read to the whole group. They concluded that children were not fluent enough in English to understand the text and therefore gave up their efforts to comprehend the story.

Storybook reading is seen as an efficient way to enhance oral language; pre-literate children thus encounter unfamiliar words in a meaningful story context (Weizman & Snow, 2001). Reading a storybook repeatedly is a common practice in many families (Sulzby, 1985) and has been found to benefit vocabulary growth in young children (Karweit & Wasik, 1996; Leung & Pikulski, 1990; Penno, Wilkinson, & Moore, 2002; Sénéchal, 1997). Repeated readings provide children with opportunity to gradually understand more of the story plot and the story language. With each new reading, story events become more predictable, leaving more time to attend to details such as specific words instead of just the overall meaning of the story (Robbins & Ehri, 1994; Snow, 1983). After a first encounter with a word in a meaningful context, a child may at best derive its partial meaning (Clark, 1993); several exposures to a word are needed for the new word to become part of children's vocabulary (De Temple & Snow, 2003; Stahl, 1999). Despite repetition, L2 children may fail to accumulate information about words and phrases. Due to a limited vocabulary in their second language, these children will experience many gaps in the story text and as a result may fail to derive the meaning of unknown words from the verbal context.

Other information sources beside the story text may be imperative for learning to occur. Nowadays, many picture storybooks are available in a digitized format that includes all the relevant qualities of the print versions while simultaneously offering new information. These digitized books can be deployed in classrooms to realize the much-needed repeated readings. With accessibility to digitized storybooks improving in line with the growing number of personal computers at home and in classrooms and with better and faster internet connections, it is essential to study which information sources in digitized storybooks assist learning.

Static illustrations in digitized storybooks are likely to facilitate word learning comparable to adult-shared storybook reading (Ninio & Bruner, 1978; Snow & Goldfield, 1983; Weizman & Snow, 2001). However, providing illustrations is not a guarantee that children will be able to extract the relevant information from the illustrations or interpret the visual information in the illustrations correctly (Peeck, 1993). Should there be many unfamiliar words, matching the visual referent with the word may be hard to achieve. In order to learn, children have to search the static illustrations for the correct visual referent, all the while rehearsing the spoken words in working memory, which increases cognitive load (Ginns, 2006). Even when children succeed in matching the visual and oral information, they still have to expand cognitive resources to reconstruct for instance motion or change from a static picture (Höffler & Leutner, 2007).

Previous experiments with digitized storybooks show that additional information such as motion, images, sound, and music hold great promise for young L2 children (de Jong & Bus, 2002, 2004; Neuman, 1997). Research shows that story comprehension benefits from independent encounters with video-storybooks to the same extent as adult-led readings (de Jong & Bus, 2004). An experiment conducted by Verhallen, Bus, and de Jong (2006) showed that L2 children benefit most from repeated encounters with the same story when the storybook includes additional information sources, such as video. By contrast, none of the studies so far supported the expectation that, as a result of video, children ignore the text that is spoken out loud (see, for example, de Jong & Bus, 2004).

However, when visual information is incongruent – unrelated or even contradictory – with oral information, this situation may interfere with the processing of oral content and, from there, seriously raise cognitive load (Anderson, Lorch, Smith, Bradford, & Levin, 1981; Hartman, 1961; Severin, 1967). However, high correspondence between visual and auditory information in video storybooks allows for a single mental image to be activated (Dubois & Vial, 2000), thus reducing cognitive load, and leaving more time to create a coherent mental model of the story (Cennamo, 1993; Dubois & Vial, 2000; Grimes, 1990; Salomon, 1983). Video additions may help children to select the important or central content connected to the story text, just as a spotlight on a stage tells the audience where to look, thus limiting the overload of information offered by illustrations containing numerous irrelevant details, and thereby helping the children integrate words, sounds, and moving images (Calvert, Huston, Watkins, & Wright, 1982; Neuman, 1997). Consequently, differences in effectiveness of the two storybook formats may be based on differences in memory load (Paas, Tuovin, Tabbers, & Van Gerven, 2003).

Story repetition may only help second-language acquisition when children remain willing to invest mental effort to process the story language. Mental effort or the cognitive capacity that is allocated to the task (Britton, Muth, & Glynn, 1986; Paas et al., 2003) presupposes non-automatic processing of a stimulus and is therefore assumed to be under the control of the individual (Salomon, 1983). The relationship between mental effort and learning may thus depend on perception of the task (Cennamo, 1993). Research with Grades 3 to 10 children corroborates this idea: children reported that they had expended more mental effort processing print than television, and the amount of effort influenced the amount of learning (Salomon, 1984; Salomon & Leigh, 1984). Video may be perceived as an easy medium because it bears much resemblance to watching television, the result being that children invest less effort in processing the content (Cennamo, 1993). In following this line of argument, we could expect that adding video to a digitized storybook may be detrimental to children's language acquisition.

It is also conceivable that mental effort decreases when the task is perceived as difficult (Field & Anderson, 1985; Salomon & Leigh, 1984). For instance, children in a study by Lorch and Castle (1997) were encouraged to watch a televised program, but still looked away from the screen one-third of the time when segments with incomprehensible language were shown. This finding suggests that visual at-

tention is especially motivated by children's current understanding of the program (Pecchinenda & Smith, 1996; Weiner, 1979). Reeves and Thorson (1986) found that overall complexity negatively affected mental effort, and that frequent breakdowns in understanding resulted in less overall expenditure of effort and lower achievement. The notion that individuals work best at tasks of intermediate difficulty because these result in higher task persistence fits this argument (Britton, Westbrook, & Holdredge, 1978; Reed, Burton, & Kelly, 1985; Thorson, Reeves, & Schleuder, 1985; Weiner, 1985).

According to the perspective of the *active theory*, children will only stay engaged to comprehend a story when they find the content challenging but within reach; children thus expect to benefit from their efforts (see, for example, Anderson & Lorch, 1983; Bickham, Wright, & Huston, 2001; Crawley, Anderson, Wilder, Williams, & Santomero, 1999; Huston & Wright, 1983). Because children are well accustomed to televised stories, they will direct their attention to cues to fill in gaps in their story schema; when all the gaps are filled, they stop paying attention (Anderson & Lorch, 1983; Huston & Wright, 1983). Results of research with three- and five-year-old children are consistent with the *active theory* (Crawley et al., 1999). During five repeated viewings of a televised story of approximately 24 minutes' duration, the visual attention of five-year-old children remained high, indicating that the children were motivated to understand the program. As expected, their comprehension of the content of the program improved but was far from complete even after repeated encounters.

When the story is hard to understand, for instance because language in television segments is rendered incomprehensible, children may compensate by investing more mental effort in the task (see, for example, Meadowcroft & Reeves, 1989), but within a finite cognitive capacity (Paas et al., 2003). Despite investing initial mental effort, children may fail to gain a basic understanding of the story (Salomon, 1983). As a result, they lose motivation to invest further mental effort and selectively disengage (Lorch & Castle, 1997; Meadowcraft & Reeves, 1989; Pecchinenda & Smith, 1996). The *active theory* may thus explain our previous finding that L2 children indeed benefit more from repeated encounters with stories, including video, but not from repeated encounters with static picture storybooks (Verhallen et al., 2006). In summary, repeating a story may not be profitable unless children's appraisals of coping options remain high.

As a first step in testing the remedial possibilities of video storybooks, we focused on a group experiencing severe educational disadvantages due to low proficiency in their first and second languages. We wondered if young second-language children would stay more attentive when the book was repeated with video than when static pictures accompanied the story text. We designed the present study to test how kindergarten children with low L2 proficiency would respond to repeated encounters with two versions of the same age-appropriate picture storybook. The events were represented either by static pictures or by video-dramatizing the story events. The story text in both versions was identical.

We circumvented another crucial difference in the sessions by presenting both versions on a computer so that only the iconic information differed. A main aim was to explore the theory that mental effort associated with repeated encounters with the story may explain variation in learning. Without additional video information, children may lose interest in the story text after a few replays and barely profit from repeated encounters with the same story. The decreasing amount of effort invested in understanding the story with every repetition of it may result in story understanding not developing further during new encounters with the same story, thus explaining why repetition of static stories is much less effective (see, for example, Detenber, Simons, & Bennett, 1998). By applying mediation analysis (Baron & Kenny, 1986), we tested the hypothesis that a sustained level of mental effort explains the added value of video.

There are several ways in which mental effort may be assessed, including self-reports, dual-task performance, and psycho-physiological measures (Cennamo, 1993). Self-reports are used in accordance with the assumption that investment of mental effort is a voluntary process, under the control of the individual and as such available for introspection (Paas et al., 2003). Young children may be unable to report how much mental effort a task has required (Geiger, 1993; Pingree, 1986). Moreover, post-viewing measures are unsuitable for estimating the intensity of mental effort during exposure to a digitized storybook. The use of a secondary task to measure mental effort (see, for example, Lorch & Castle, 1997) is based on the assumption that if the first task requires more mental effort, little mental effort is left for the performance on a secondary task. Although most secondary tasks are simple, such as detecting a visual signal, they can interfere considerably with the primary task, especially if the primary task is complex, as is the case with story language comprehension (Meshkati & Loewenthal, 1988; Paas et al., 2003). Furthermore, the outcomes of a secondary task are not always congruent with self-report results (Beentjes & van de Voort, 1993). Comprehensibility of a television program has been found to influence visual attention (Anderson, Lorch, Field, & Sanders, 1981; Lorch, Anderson, & Levin, 1979). But as an indicator of mental effort, visual attention is less suitable. Even when a child is visually attentive, we cannot know how much mental effort he or she devoted to processing the story (Lorch & Castle, 1997).

Taking the above-mentioned results into account, we used skin conductance responses (SCRs) as an indicator of children's mental effort (Dawson, Schell, & Filion, 1990; Pecchinenda & Smith, 1996), similar to use in other studies of learning (Carpenter & Haddan, 1966; Clariana, 1989, 1992; Clariana & Schultz, 1991). The main advantage of SCRs over other physiological measures such as cardiac responses is that small changes in SCRs can be easily discerned while changes in cardiac responses as a result of experimental manipulations are more difficult to discern because of other causes of variance in heartbeats (Dawson, Schell, & Filion, 2000). Earlier research shows that intra-individual variations in the frequency of SCRs are quite small (Fahrenberg & Foerster, 1982; Wahlschburger, 1976) even over longer periods (Clariana, 1992).

Unlike event-related skin conductance activity, spontaneous or non-specific SCRs are considered to be an indicator of the amount of attention and effort a person is devoting to a task. As such, SCRs reflect an effortful allocation of resources to a task (Dawson et al., 1990; Pecchinenda & Smith, 1996; Sundar & Kalyanaraman, 2004). Research by Pecchinenda and Smith (1996) showed that the mental effort derived from skin conductance activity was determined by appraisals of coping potential. Mental effort broke down when the task became too difficult and the hope of successfully completing it was lost. In other words, non-specific SCRs indicate mental effort that, in turn, is influenced by appraisal of coping potential. Assessing children's mental effort using skin conductance activity allowed us to examine the intensity of mental effort during repeated exposures to a digitized storybook, without the interference of a secondary task and without relying on self-reports.

To summarize, we aimed to test the following three hypotheses:

1. When children experience gaps in story text understanding, repetition of a story supports language acquisition, especially when video is added.
2. When children do not experience sufficient support in figuring out the meaning of the story text, they will cease to invest mental effort in processing the story content after a few sessions, as indicated by a decrease in number of skin conductance responses.
3. A sustained level of mental effort elicited by video storybooks may function as a generative mechanism through which video is able to improve language acquisition.

## Method

### *Design*

Participants ( $N = 106$ ) were randomly assigned to one of five conditions. In addition to a control group, there were four treatment groups crossing two levels of story format (with or without video) with two levels of repetition (one or four exposures). In order to keep the number of sessions equal, all children participated in four sessions. Children in the 1x condition (one encounter with the focal story) played with a non-verbal computer game during the three sessions that preceded the session in which the children heard the story. During the story encounters, we registered skin conductance activity during intervention sessions as an indicator of mental effort. To test whether mental effort continued over sessions and if consistency of mental effort affected language acquisition, we focused on a sub-sample, namely the 4x video and 4x static groups ( $n = 42$ ).

### *Participants*

We selected, from 48 classrooms (13 schools), 106 children with the highest at-risk status (0.9) that the Dutch school system acknowledges. The government distributes educational funding on the basis of a combination of educational level and ethnic origin of the parents. A student weighting of 0.9 refers to a child with parents

with a low educational level from an ethnic minority group who learns Dutch, the language of instruction, as a second language. The selected children were judged as most at risk for reading problems (Bosker & Guldmond, 2004). All children were from the two largest groups of immigrant families in the Netherlands; they spoke Turkish, Moroccan-Arabic, or Berber at home (van Praag, 2003). At the start of formal education at the age of four, these children, like most immigrant children, would have had little exposure to Dutch, the language of instruction in preschool and kindergarten classes (Verhoeven, 2000, 2007).

The process we used to select subjects involved three steps:

1. We contacted inner-city schools in The Hague that had, according to the school administration, at least 80% immigrant children from low-educated families.
2. With the help of information provided by teachers and school administrations, we made a first selection of students based on the following criteria: (a) five years old; (b) speak Turkish or Moroccan-Arabic, or Berber at home; (c) have received instruction by means of a second-language educational program in immersion classes from the time they started attending school (the day they became four years old); and (d) have no special language impairments or special educational needs.
3. We then gave each child tests so that we could select children according to the following three criteria: (a) scored at the level of the lowest 50% on a language test standardized for Dutch kindergarten children (as is true for about 90% of this at-risk population); (b) non-verbal intelligence is in the normal range; and (c) is not familiar with the focal story.

We continued this recruitment process until we had found a sufficient number of eligible subjects.

Table 1 shows the characteristics of the five groups involved in the experiment. The groups (one baseline group and four treatment groups) were similar in terms of ethnic background, educational level of the parents, age ( $F(4, 101) = .11, n.s.$ ), scores on the Cito Language Test ( $F(4, 101) = .51, n.s.$ ), and scores on the Raven's Colored Progressive Matrices ( $F(4, 101) = 1.49, n.s.$ ).

**Table 1:** Characteristics of Subjects per Condition

|          | <i>n</i> | Ethnicity<br>(Turkish/<br>Moroccan) | Gender<br>(M/F) | From<br>families<br>with a low<br>level of<br>education | Schools/<br>classes <sup>1</sup> | Age<br>in months<br>Mean<br>scores (SD) | RPM<br>Mean<br>standardized<br>scores (SD) | Cito Language<br>Test<br>Mean<br>standardized<br>scores (SD) |
|----------|----------|-------------------------------------|-----------------|---|----------------------------------|---|--|--|
| Static   | 1x       | 23                                  | 11/12           | 23  | 9/21                             | 67.43 (3.67)                            | 4.63 (1.45)                                | 57.26 (5.45)   |
|          | 4x       | 20                                  | 10/10           | 20  | 9/19                             | 67.35 (3.42)                            | 4.06 (1.49)                                | 57.40 (5.72)   |
| Video    | 1x       | 21                                  | 11/10           | 21  | 10/16                            | 67.81 (2.68)                            | 4.88 (1.94)                                | 58.10 (5.27)   |
|          | 4x       | 22                                  | 11/11           | 22  | 10/18                            | 67.23 (2.98)                            | 4.46 (1.48)                                | 56.45 (6.60)   |
| Baseline |          | 20                                  | 10/10           | 20  | 5/11                             | 67.30 (2.75)                            | 5.25 (1.84)                                | 55.75 (5.72)   |
| Total    |          | 106                                 | 53/53           | 106   | 13/48                            | 67.42 (3.08)                            | 4.65 (1.66)                                | 57.00 (5.72)   |

<sup>1</sup> The number of schools and classes from which children were recruited.



### *Procedure*

Each child worked at the computer in a room other than the classroom during four separate sessions spread over approximately nine days. The other persons present in this room were the experimenters, one of whom instructed the child; the other was responsible for registering skin conductance. At the start of the sessions, the experimenter placed electrodes on the child's hand to register skin conductance activity. The first time, the experimenter explained at length what she was doing and applied the electrodes to her own hand to show that they would not hurt. None of the participants gave the impression that they experienced the device as aggravating or frightening.

### *Intervention programs*

The Dutch CD-ROM *Heksenspul*, a translation of an English CD-ROM (*Winnie the Witch* by Thomas & Gorky, 1996), includes a version with merely static illustrations and a version that includes video representations. The static version consists of 22 screens with static illustrations. The text is read aloud after a click at the start of the text. In the video version, the static illustrations representing the story events are dramatized congruent with the story text. Motion and camera work (cuts, pans, and zooms) guide children in selecting the important or central elements of pictures that relate to the story text. The text, exactly the same for both versions, is read by the same voice. We chose a story with all the characteristics of a classical story scheme: a problem (everything in the house is black, including the cat, which causes the witch to stumble over her cat time after time) generates a series of solutions (first transforming the cat into a green cat and later into a cat in all the colors of the rainbow) that in turn creates new problems and new solutions to these problems until the most obvious solution is found (transforming the house into a house with colors and the cat into a black cat).

### *Selection tests*

Children's Dutch language proficiency was assessed with the CITO standardized Language Test for Senior Kindergarten Children (CITO, 1996).<sup>1</sup> Children with scores belonging to the lowest 50% of the Dutch norm group were included in the study. The Dutch version of Raven's Colored Progressive Matrices (Van Bon, 1986) was used to assess non-verbal intelligence. Children scoring within the normal range were selected.

To assess familiarity with the focal book, children were presented with 12 pictures on a computer screen: six of the pictures came from well-known children's picture storybooks, including the stimulus book. Once children knew the title of the stimulus book (*Heksenspul*), were able to name the main character (*Winnie the Witch*), or could tell the story, they were excluded from participation.

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1 CITO is a Dutch organization involved in test development.

*Tests to Assess Effects of the Intervention*

To assess growth in story language, we used the first part of the test to test expressive knowledge of 42 content words from the *Winnie the Witch* story. We used the second part to test expressive knowledge of sentences. Here, the children were asked to repeat a selection of sentences from the story text.

In the first part of the test, the children filled in the last word of a stimulus sentence that the experimenter orally presented while the children saw a matching picture on the computer screen. For instance, “The cat lies on the ... (carpet)” was accompanied with a picture of a cat lying on the carpet. These words, selected from the story text, have a low frequency and are therefore assumed to be unknown by most participants (Schrooten & Vermeer, 1994). This set included nouns (*heks – witch; rozenstruik – rosebush; gras – grass; tapijt – carpet*), adjectives (*snorrend – purring; woedend – furious*), and verbs (*struikelen – stumble*). Two words (*witch* and *grass*) were known by the majority of children (80% or more) at pre-test and therefore excluded. One test item familiarized children with the test.

The second part was made up of 24 sentences, each with an average length of eight or nine words ( $SD = 2.57$ ). Elicited sentence imitation is seen as a reliable indicator of second-language competence (Ellis, 2001) because it is influenced by long-term knowledge of language (Speciale, Ellis, & Bywater, 2004). We scored the number of correctly repeated sentences. One sentence was correctly repeated by the majority of children (80% or more) at pre-test and therefore excluded. So that children would become familiar with the test, they were given opportunity to practice with a simple sentence until they could correctly repeat that sentence without assistance.

Because the correlation between the word knowledge test and sentence repetition was substantial ( $> .60$ ), we calculated one score for story language. We then computed an average z-score. Internal consistency of the tests was fair: alpha reliabilities for the pre- and post-test were .78 and .85, respectively. The inter-rater reliability for vocabulary was .99 and for repeating sentences .94.

*Skin conductance*

We used an ambulatory monitoring device to register skin conductance activity during the story reading. The skin conductance was registered every 500 msec by applying a constant voltage (0.5V) to Ag/AgCl electrodes placed on the palmar surfaces of the medial phalanges of the second and third fingers of the non-dominant hand. The electrodes were secured by soft tape. As a conductive medium between the electrodes and skin, we applied an electrolyte paste consisting of physiological saline (9% NaCl) in a Unibase.

We used a computer program to assess the number of spontaneous SCRs with amplitudes higher than .02 micro Siemens (Kroonenberg, 2004). Fluctuations in skin conductance of .02 micro Siemens were considered as “spontaneous” or “non-specific” SCRs (Boucsein, 1992). Non-specific SCRs are commonly expressed as a rate per minute (Pecchinenda & Smith, 1996; Ravaja, 2004). During the first ex-

periment, we started out with hand-electrodes, attached to the thenar and hypothenar eminences of the palms. Displacement of the hand-electrodes due to movement spoiled measurements in the first session, so we switched to finger-electrodes in the second session. Because there is a linear relationship between the size of an electrode and the number of non-specific SCRs (Mahon & Iacono, 1987), the results found in the first session could not be compared with results of subsequent sessions; we accordingly ignored the first session. We excluded three children from the analyses because the registration in one or more sessions was invalid as a result of mechanical problems.

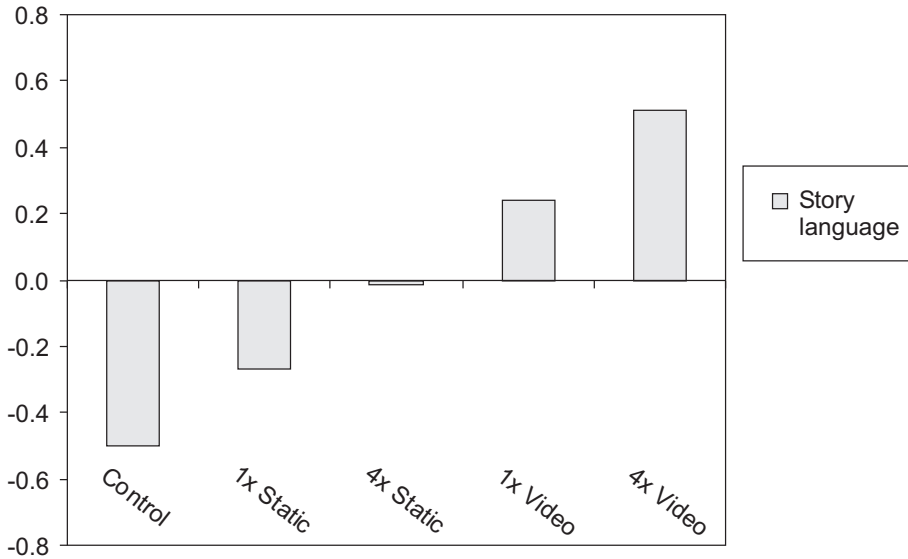
## Results

### *Effects of video additions*

Table 2 shows the mean scores on knowledge of story language per group. To test whether repetition of a story supports only language acquisition when video is added, we performed ANOVAs with treatment as the independent variable and story language as the dependent variable. Assumptions of normality of sampling distribution and homogeneity of variance were tested and approved. As there was no statistically significant effect of treatment on the pre-test score, we had a strong assurance that experimental conditions did not differ in a measure that could have interfered in subsequent analyses. An ANOVA with treatment as independent variable and post-test as the dependent measure revealed a statistically significant main effect for treatment,  $F(4, 101) = 4.59, p < .002, \eta_p^2 = .16$  (see Figure 1).

To analyze which treatments caused the overall treatment effect, we tested eight contrasts: the four treatments versus the control group; the video versus static group after one and four sessions; and effects after one session with effects after four sessions for the video and static group separately. Type I error rate was controlled by subjecting comparisons to family-wise error correction applying the Šidák-Bonferroni procedure (Keppel & Wickens, 2004). With eight comparisons at  $\alpha = .05$  level, the individual tests were evaluated at the 0.639% level. Contrasts between the treatment groups and the control group revealed a statistically significant contrast favoring 4x video,  $F(1, 101) = 14.19, p < .000, \eta_p^2 = .13$ , but contrasts between the control group and 1x video, 1x static, and 4x static were not significant. No other contrasts reached significance. The contrast between 4x static and 4x video was marginally significant,  $F(1, 101) = 3.68, p < .058, \eta_p^2 = .04$ , in favor of 4x video.

**Figure 1:** Mean z-scores for Story language (post-test)



**Table 2:** Mean Scores and Standard Deviations on Tests to Measure Knowledge of Story Language in Percentages

|           | n   | Words                     |               | Sentences     |               | Combined z-scores |            |
|-----------|-----|---------------------------|---------------|---------------|---------------|-------------------|------------|
|           |     | Pre-test                  | Post-test     | Pre-test      | Post-test     | Pre-test          | Post-test  |
| 1x static | 23  | 11.41 (5.21) <sup>1</sup> | 17.39 (7.21)  | 10.02 (9.22)  | 11.15 (8.58)  | -.03 (.76)        | -.27 (.66) |
| 4x static | 20  | 11.38 (6.10)              | 20.75 (11.24) | 8.91 (12.34)  | 13.48 (12.77) | -.08 (.87)        | -.01 (.92) |
| 1x video  | 21  | 13.93 (7.36)              | 21.79 (8.70)  | 13.25 (12.41) | 18.43 (17.00) | .32 (1.03)        | .24 (1.00) |
| 4x video  | 22  | 12.95 (6.06)              | 26.76 (8.80)  | 9.88 (11.56)  | 18.77 (14.10) | .09 (.85)         | .51 (.87)  |
| Control   | 20  | 8.38 (4.54)               | 13.00 (7.50)  | 9.13 (9.96)   | 11.09 (9.62)  | -.32 (.76)        | -.50 (.68) |
| Total     | 106 | 11.65 (6.10)              | 20.02 (9.76)  | 10.25 (11.03) | 14.60 (12.97) | 0.00 (.87)        | 0.00 (.90) |

Note: <sup>1</sup> Standard deviations in parentheses.

*Rate of SCRs*

Next we tested whether the SCR rate remained at the same level or changed with repetition of the story. We assumed that children would only invest mental effort in processing the story content after a few sessions if they experienced sufficient support in figuring out the meaning of the story. We performed an ANOVA with repeated measures for the second, third, and fourth sessions and by format (video versus static). For reasons explained above, we ignored the findings of the first session. In three cases, we experienced mechanical problems, resulting in 22 subjects in the video condition and 17 in the static condition. Results of the evaluation of assumptions relating to normality of sampling distribution and of homogeneity of variance were satisfactory. Table 3 shows the average rate of SCRs as a function of format and session number.

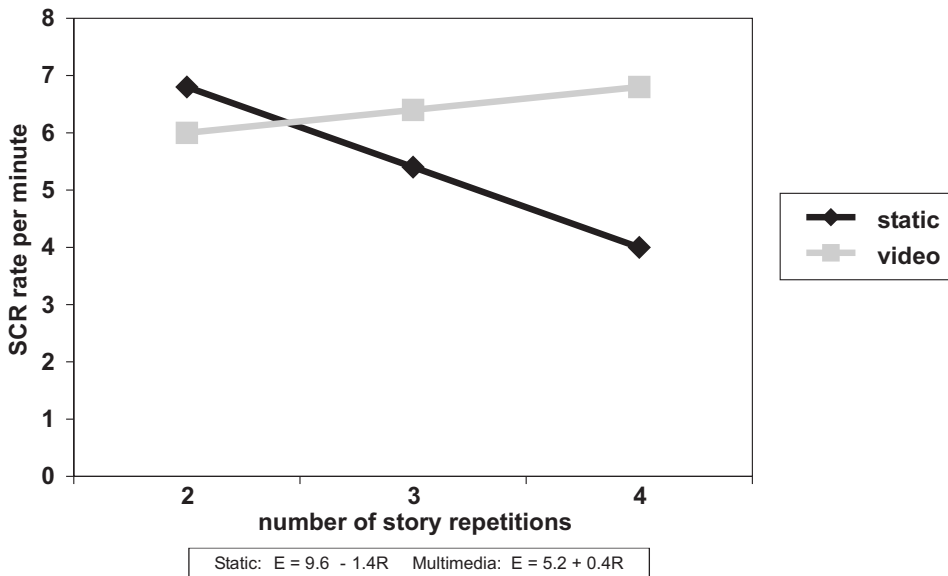
**Table 3:** Mean Rate of Skin Conductance Responses (SCRs) in the Second, Third, and Fourth Sessions (N = 39)

| Session number         | SCR rate                 |             |
|------------------------|--------------------------|-------------|
|                        | Static                   | Video       |
| Winnie the Witch 2     | 7.13 (5.26) <sup>1</sup> | 6.21 (3.48) |
| Winnie the Witch 3     | 5.56 (3.13)              | 6.35 (3.82) |
| Winnie the Witch 4     | 4.40 (3.06)              | 7.09 (4.17) |
| Winnie the Witch total | 5.69 (3.22)              | 6.55 (2.93) |

Note: <sup>1</sup> Standard deviations in parentheses.

Format or session number did not cause main effects. However, the linear trend for session number varied significantly with format, as evident from the statistically significant interaction (linear) between session number and story format,  $F(1, 35) = 5.31, p < .03, \eta_p^2 = .13$ . This interaction was due to a slight linear increase in the video condition,  $E = 5.2 + 0.4R$ , where E is the rate of skin conductance responses (SCRs) per minute and R is repetition. By contrast there was a significant linear decrease in rate of SCRs for the static condition,  $E = 9.6 - 1.4R$  (see Figure 2). Repetition thus resulted in a stable number of spontaneous SCRs in the video condition, while the rate of spontaneous SCRs significantly declined in the static condition,  $t(df = 16) = 2.54, p < .02$ . Three post hoc comparisons testing the difference between the video format and the static format for each session separately revealed a statistically significant difference for Session 4 ( $t(df = 37) = 2.23, p < .03$ , two-tailed), but not for Sessions 2 and 3.

**Figure 2:** Linear increase in the Video Condition and Decrease in the Static Condition, Where E is the SCR Rate per Minute and R is the Order of Repetition



This result agreed with our prediction that, in regard to the video additions, the children would retain a relatively high level of mental effort, as evidenced by skin conductance activity, when they encountered the same story time and again. A mean score of 6–7 SCRs per minute is quite high compared to a typical rate of 1–3 SCRs per minute for subjects at rest (Dawson et al., 2000). By contrast, when the children were presented with static pictures only, they seemed to lose interest after a few repetitions, as indicated by a decrease in SCR rate from 7 in the second session to 4 in the fourth session.

#### *Skin conductance responsivity as mediator*

In order to test whether a sustained level of mental effort elicited by video storybooks functions as a generative mechanism through which video is able to improve vocabulary acquisition, we applied the logic of a mediational analysis. We tested whether SCR was a possible mediator between video additions and language acquisition (Baron & Kenny, 1986). The correlations in Table 4 indicate possible mediation between video and story language, with the stability of skin conductance responsivity serving as a mediator between these variables, as illustrated in Figure 1. Probably because of differential exposure to the Dutch language (Leseman et al., 2009), the Moroccan children scored, on average, higher on the story language post-test ( $r = .42, p < .004$ , one-sided; Table 4). We therefore included ethnicity as a covariate in all regression analyses. We also tested and approved assumptions of normality of sampling distributions, linearity, homoscedasticity, and independence of residuals. We used one-sided directional tests because the predicted pattern includes specific directionality (Levin & Neumann, 1999).

**Table 4:** Zero-Order Correlations among Measures

|  | Gender | Age   | Raven | Ethnicity | Video | Mean skin conductance response rate | Increase in skin conductance response rate | Story language post-test |
|--|--------|-------|-------|-----------|-------|-------------------------------------|--|--------------------------|
| Gender                                     | ---    |       |       |           |       |                                     |  |                          |
| Age  | .19    | ---   |       |           |       |                                     |  |                          |
| Raven (standardized)                       | -.24   | .03   | ---   |           |       |                                     |  |                          |
| Ethnicity                                  | -.03   | -.35* | -.17  | ---       |       |                                     |  |                          |
| Video                                      | -.03   | -.05  | .17   | -.03      | ---   |                                     |  |                          |
| Mean skin conductance Response rate        | .22    | -.06  | .15   | -.16      | .14   | ---                                 |  |                          |
| Increase in skin conductance Response rate | -.20   | .09   | .12   | -.02      | .37** | -.08                                | ---  |                          |
| Story language (post-test)                 | -.12   | -.03  | .11   | .42**     | .27*  | -.31*                               | .32*                                       | ---                      |

Note:  $N = 39$ ; \*  $p < .05$  \*\*  $p < .01$  (1-tailed).

In the first regression in Table 5, with the mediator (SCR) as criterion (path a), video additions accounted for 13% ( $p < .05$ ) of the SCR rate. When testing path b (the relationship between the mediator (SCR) and language acquisition (dependent variable)), we controlled for the effect of video because both the stability of the SCR rate and the post-test can be caused by video additions. This relationship is shown by the second regression in Table 5, where stability of skin conductance responsiveness accounted for an additional 6% ( $p < .05$ ) of the unique variance in language acquisition. Because both paths a and b were statistically significant, mediation was indicated. Third, the independent variable (video) must be related to the dependent variable (language). This relationship is shown in Table 5, where video additions accounted for an additional 8% ( $p < .05$ ) of the unique variance in language. The fourth regression of Table 5 shows that the significance of video additions as a predictor of vocabulary changed from significant to non-significant when the mediator was controlled, indicating a complete mediation of stability of skin conductance responsiveness (Kenny, 2005). Figure 3 summarizes these results.

**Table 5:** Four Hierarchical Regressions to Test the Mediation Function of Increase in Skin Conductance Response Rate

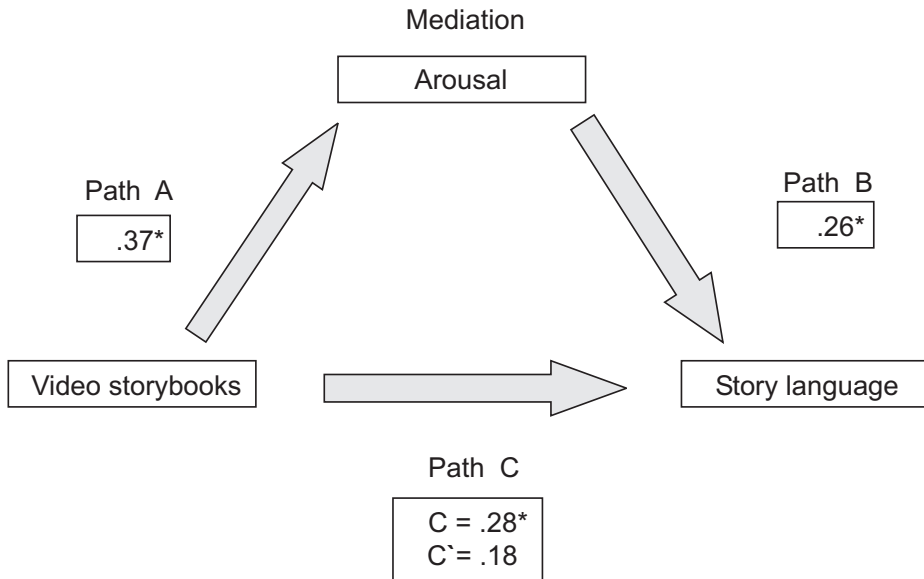
| Step  |  | R   | R <sup>2</sup> change | F change <sup>1</sup> | Final β <sup>2</sup> |
|---|--|-----|-----------------------|-----------------------|----------------------|
| <i>Regression 1: Effects of video additions on increase of skin conductance response rate, controlling for ethnicity</i>                    |  |     |                       |                       |                      |
| 1   | Ethnicity                                  | .02 | .00                   | .02                   | -.01                 |
| 2   | Video                                      | .37 | .13                   | 5.53                  | .37*                 |
| <i>Regression 2: Effects of skin conductance response rate on story language, controlling for ethnicity and video additions</i>             |  |     |                       |                       |                      |
| 1   | Ethnicity                                  | .42 | .18                   | 8.00                  | .43**                |
| 2   | Video                                      | .51 | .08                   | 3.74                  | .18                  |
| 3   | Increase in skin conductance response rate | .56 | .06                   | 2.93                  | .26*                 |
| <i>Regression 3: Effects of video additions on story language, controlling for ethnicity</i>  |  |     |                       |                       |                      |
| 1   | Ethnicity                                  | .42 | .18                   | 8.00                  | .43**                |
| 2   | Video                                      | .51 | .08                   | 3.74                  | .28*                 |
| <i>Regression 4: Effects of video additions on story language, controlling for ethnicity and increase in skin conductance response rate</i> |  |     |                       |                       |                      |
| 1   | Ethnicity                                  | .42 | .18                   | 8.00                  | .43**                |
| 2   | Increase in skin conductance response rate | .53 | .11                   | 5.29                  | .26*                 |
| 3   | Video                                      | .56 | .03                   | 1.50                  | .18                  |

Notes: N = 39.

<sup>1</sup> Use of directional tests: critical value of F equals 2.85.

<sup>2</sup> \* $p < .05$  \*\*  $p < .01$  (1-tailed).

**Figure 3:** Mediation Model Indicating that Increase in SCR Rate Mediates the Relationship between Video Additions and Vocabulary



Note: The numbers on the arrows are standardized regression coefficients; \*  $p < .05$ .

Due to the correlational nature of some data, it is possible that arousal remained at a higher level because the children's gains in story language made the story more engaging for them. To express this idea differently, the relationship between video additions and stability of skin conductance responsivity may have been mediated by story language. However, when we applied the logic of mediational analysis to story language as a possible mediator of the relationship between video and stability of skin conductance responsivity, we found no statistical support for this model. On inspecting the separate paths, we found that mediation was indeed indicated but that the significance of video additions as a predictor of stability of skin conductance responsivity did not change from significant to non-significant when story language was controlled, indicating that the relationship between stability of skin conductance responsivity and video was not mediated by familiarity with the story language.

## Discussion

The findings of our study make plausible the notion that second-language learners lose interest after a few replays of the same story, as is often suggested in the literature on book reading (see, for example, Leung & Pikulski, 1990). In line with this hypothesis, when the children were exposed to the digitized book version with static illustrations of *Heksenspul (Winnie the Witch)*, their mental effort decreased



with every replay. This finding may explain why these children's language did not benefit from repeated encounters. However, repetition does not, by definition, result in a gradual decrease of mental effort. A unique result of the present study is that the children's level of mental effort remained at a high level when the story included additional information sources such as video. This finding indicates that, for L2 learners, video instead of static pictures is essential (Lang, 2006). It seems a plausible assumption that the children in the video condition may have retained a higher level of mental effort because they experienced the video version as more supportive of their text comprehension than did the children exposed to the book with static illustrations.

This assumption was corroborated by the outcomes of the language tests used in this experiment; children who heard the story four times with video additions learned substantially more story language than the children who had heard the story with static pictures. It seems that when young children who have low L2 proficiency experience the available information sources as more helpful, they are more inclined to continue their efforts to figure out the meaning of text in every replay of the story, thereby improving their understanding of words and phrases. However, when non-verbal information used to support understanding of the story events is less helpful and the children are thus more dependent on the (oral) text to understand the story events, the children may cease to invest mental effort. In a similar vein, research into effects of language comprehensibility on visual attention in young children shows that televised stories, edited so that language is incomprehensible, initially elicits visual attention. However, when comprehension is found to be unattainable, there is a subsequent decrease in children's visual attention (Anderson & Lorch, 1983; Anderson et al., 1981; Pingree, 1986).

We did not find support for the hypothesis that mental effort is just a side-effect of improving story understanding. If that had been the case, the relationship between video and mental effort would have been mediated by language growth. But this assumption did not hold true. On the contrary, we found evidence for the theory that sustained mental effort resulting from a better story understanding plays an essential role in the causal chain of learning from repeated encounters with stories. Sustained mental effort mediates between video additions and linguistic understanding. Our findings match best with the so-called *active theory* that was developed to explain learning from television viewing (Anderson & Lorch, 1983; Bickham et al., 2001; Huston & Wright, 1983). In line with this theory, children continue to invest more mental effort in utilizing or processing what they see and hear when they perceive the story as more comprehensible (Crawley et al., 1999). This investment, in turn, promotes memorization of so-far unknown language. Children who comprehend the story quite well after one or two encounters would, in accordance with the *active theory*, not be expected to continue to invest mental effort after repeated encounters. We would expect that mental effort would drop after a few repetitions.

This influence of perception of comprehensibility of a story on mental effort expenditure aligns with research on the relationship between appraisals of problem-

focused coping potential and mental effort (Pecchinenda & Smith, 1996). In this research, the rate of SCRs significantly correlated with task performance: the rate was maintained during trials with tasks of moderate difficulty that were perceived to be attainable, but declined during tasks that were perceived as too demanding (Pecchinenda & Smith, 1996). It seems less plausible, then, that the sustained mental effort results purely from curiosity elicited by the dynamic characteristics of video. Wright and colleagues (2001) showed that television by itself is not an incentive for learning, however, comprehensibility of the content is.

Although numerous studies suggest that repeated encounters with the same story are effective, the manner in which repetition affects language acquisition has so far hardly been explored (see, for example, Bus et al., 1995; Frijters et al., 2000; Sénéchal, 1993, 1997). Our study confirms that repeated encounters with the same picture storybook are a necessary but not a sufficient prerequisite for the development of language. Repetition is stimulating on condition that the book features match children's needs by sustaining their mental efforts. When motion and camera work guide children through the images simultaneously rather than successively with the corresponding narration, then learners can engage in integrating text with sounds and moving images. This result suggests that sometimes learning might be enhanced more through media that are "easy" and less by media that are more "tough," such as traditional picture storybooks (Neuman, 2009).

In the very same way, repeated parent-child book sharing may be effective because an adult sensitive to children's needs keeps them interested and attentive by pointing at the picture or adding other clarifications, thereby promoting learning. Note that because book reading at home and in school may not always fulfill these requirements, children may lose interest similar to our subjects in the static book condition. Video in digitized storybooks may solve such problems. Note also that the present findings hold true for children with numerous gaps in their text understanding, as the participants in our study were unfamiliar with about 10% of all words in the story text, a percentage comprising a very substantial part of the story vocabulary. We can imagine that children become less dependent on external support when gaps in their text understanding are fewer.

In summary, the assumption that story repetition is an effective strategy (see, for example, Biemiller & Boote, 2006) is supported but also nuanced by the present pattern of results. The fact that just repeating a story was not sufficient to advance vocabulary among this group of children with low L2 proficiency is a remarkable finding. Repeated encounters with the same story only affected language acquisition when the children continued to invest mental efforts in understanding the story text. What these findings tell us is that stories must have an appeal to children that motivates them again and again with every replay. Or, to word this claim another way, the non-verbal presentation of the story must be of such high quality that children perceive the story to be comprehensible even when they experience many gaps in the story text.

The surplus value of video storybooks, then, is not that they add new media. Rather, the deciding factor is the helpfulness of these additional information source-

es. For this reason, the quality of video stories has to comply with the strictest requirements. Those designing video storybooks should set story content and not the entertainment value as the main source of inspiration. Moreover, they should have as a priority adding visual information congruent with the story text and using cinematic techniques such as zoom to guide children's attention to important visual information, thereby making the story more understandable. They should not add incongruent animations that may distract children's attention (Labbo & Kuhn, 2000). Understanding more of the story is essential for language expansion because it provides a helpful context within which to derive the meanings of unfamiliar words.

## **Limitations and Future Directions**

It is important to remember that the present results apply to kindergarten children who, in comparison to their peers, lag behind in understanding the language of teaching and so are at great risk of developing a reading problem at school. Even though we did not compare groups of children differing in risk status, we consider as a plausible assumption the notion that (especially) children with relatively low L2 proficiency need extra sources of information in the form of video to sustain engagement. However, this assumption has not been tested by contrasting children at risk of reading failure with children not at risk of reading failure. We could expect less pronounced results in average groups because these children are less dependent on scaffolding for understanding the story text. For now, it is important to conclude that the additional information available in video stories seems to stimulate at-risk children to sustain a high level of mental effort, thus enabling these children to profit from repeated encounters with age-appropriate stories. We also emphasize that these findings relate to a substantial part (about 18%) of the primary school population in the Netherlands.

Note also that several pieces of the puzzle are still missing. While we can assume that temporal contiguity may enable children to build referential connections between verbal and non-verbal representations, thus stimulating learning from repeated encounters with the story, we do not yet have a direct test of this presumption. However, if this assumption is correct, we may, for instance, expect that overall eye fixations are more to the point with video stories than with static stories.

In this study, we focused on children most in need of remediation. Future studies should be designed to test if similar effects can be found in groups differing in risk status.

## Summary and Practical Implications

The findings of this study add new evidence to the theory that, by letting kindergarten children interact repeatedly with video storybooks, teachers have a powerful tool at their disposal to stimulate young children's academic language, a precursor to their becoming proficient readers. The most important finding of the study is that video storybooks – a way of presenting stories in this computer era that is growing in importance – support repeated encounters with stories because they seem better able than static stories to preserve mental effort. Reduction in mental effort as the story is repeated (a plausible side-effect of repeating the same static story time after time) poses less of a threat to video storybooks probably because children's appraisals of coping potential remain at a higher level. Video storybooks are sufficiently engaging for young L2 children at risk to keep them attentive even when they fail to understand (parts of) the text in age-appropriate stories, a result supporting the use of computer technology in pre- and early school education.

Of course, book sharing with an adult may produce similar or even better results (Bus, 2001), but high-quality support is often not available in school or at home (see, for example, Bus, Leseman, & Keultjes, 2000). As yet, the position of computer technology in classrooms is of minor importance and video storybooks are seldom part of the curriculum, even though computers are winning ground in preschools and kindergartens. The present finding that kindergarten children at risk show more spontaneous investment in understanding video stories argues for a cultural shift. These media may be assets rather than liabilities, giving new possibilities to kindergarten children who, in comparison to their L1 peers, lag behind in language proficiency and are at great risk of developing a reading problem at school (Tyner, 1998). The pleasure children experience because of their successful encounters with the video storybooks may positively influence their stance toward reading in subsequent years (Baker, Scher, & Mackler, 1997)

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