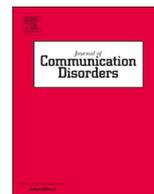


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Contribution of reading an e-book with a dictionary to word learning: Comparison between kindergarteners with and without SLI

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ABSTRACT

The purpose of the current study was to examine the efficacy of e-book reading to promoting word learning among kindergarteners with specific language impairment (SLI) compared to those with typical language development (TLD). We also tested the contribution of three types of dictionary support provided in the e-book. All dictionary words were given a pictorial and auditory support while a third of them were given a short definition, a third were defined using the story content, and a third were given a combined definition. Twenty kindergarteners with SLI and 20 with TLD were read the e-book with dictionary support 5 times. Each child was exposed to the three types of dictionary support in each e-book reading. Receptive knowledge, word definitions and use of target words were measured pre and post intervention. A significant improvement in new word learning following the e-book reading was found in the children's receptive knowledge, word definitions and use of target words. Nonetheless, children with TLD progressed in words use more than children with SLI. The two groups progressed to a greater extent in explaining new words following the provision of a dictionary definition and following story context definition. Children with SLI progressed in words' use following the definition of a dictionary. The combined definition was especially efficient for children in the two groups with had a low initial level of using new words. Combined definition was also efficient for explaining new words for TLD children with initially high language level. We conclude that children with SLI like children with TLD can benefit from ebook reading and can learn new words at different levels when the e-book is well designed in assisting children with definitions of difficult words.

1. Introduction

1.1. Vocabulary and ways for learning new words

Vocabulary acquisition at a young age is a significant component of language learning, and has implications for children's academic success (Penno, Wilkinson, & Moore, 2002; Verhoeven & Perfetti, 2011). Insufficient vocabulary acquisition may compromise the learning process, as in the case of children with Specific Language Impairment (SLI) (Baker, Simmons, & Kame'enui, 1998; Lawrence, Capotosto, Branum-Martin, White, & Snow, 2012; Levie, Ben-Zvi, & Ravid, 2017). The vocabulary of children with SLI, which may have been acquired later than expected (Leonard, 1998), tends to be smaller, resulting in their lower performance on

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standardized tests (Gray, Plante, Vance, & Henrichsen, 1999). The aim of this study was to investigate an interventional approach to word learning, and to document its efficacy among children with SLI. Our findings will enable educators as well as clinicians to consider the value of this approach when planning their intervention or treatment. Furthermore, the use of multimedia for examining the word learning process in children with SLI will allow us to understand the contribution of e-books as a possible source for supporting substantial learning. Multimedia literature proposes that different media of communication (e.g., pictorial and auditory support) may especially enhance the learning of children from disadvantaged groups, SLI among them (Bus, Takacs & Kegel; Shamir & Korat, 2015).

One of the prominent difficulties of children with SLI compared to their typically language developing (TLD) age-matched peers is in learning words (Kornilov, Magnuson, Rakhlin, Landi, & Grigorenko, 2015), which may be expressed in understanding words, and to a greater extent in new word production. These children need repeated and diverse activities as well as structured and non-random guided teaching in order to acquire words (Gray, 2003; Kan & Windsor, 2010). It should be noted that children with SLI can also learn new words through random learning, as do age-matched children with TLD, yet they do this less effectively partly because of their difficulty to understand and produce novel words after a limited number of exposures (Steele & Mills, 2011). Direct teaching within the linguistic context may therefore improve their ability to learn the meaning of new words (Gray, 2003; Smeets, van Dijken, & Bus, 2012; Steele & Mills, 2011).

Receptive and expressive word knowledge are considered two important aspects of language proficiency which develop rapidly in young children (Altman, Goldstein, & Armon-Lotem, 2017; Altman, Goldstein, & Armon-Lotem, 2018; Dromi, 1987; Llach, & Gómez, 2007). Different types of support may enhance young children's learning of words as they move from one learning level to the next. Empirical knowledge and use of new technology may increase our understanding of the efficiency of means available to parents, professional staffs and policy makers. This paper aims to shed light on children with SLI as well as on typically developing children's receptive and expressive word learning via e-book reading using varied types of dictionary support.

Children learn the meaning of new words mainly by random learning through context (Nagy & Herman, 1987; Nagy & Scott, 2000). This type of learning is known as "quick incidental learning" (Rice, 1990), which is an independent rapid unconscious process without adult mediation. According to Rice (1990), this process is not necessarily effective, since it does not supply the word's whole meaning and therefore, additional exposures in other contexts are usually necessary. Another way of learning new words is through direct, explicit teaching, which includes adult mediation (Beck, McKeown, & Kucan, 2013; Nash & Donaldson, 2005; Penno et al., 2002). This may include an attempt to match the word definition to the child's cognitive and linguistic level, in order to facilitate the learning. Mediation is performed via the use of synonyms that are familiar to the child, or by presentation of a word definition (Penno et al., 2002). Intervention studies, which used explicit word teaching in a linguistic context (i.e., books) including illustrations that combine the content with the specific context, showed benefits in word learning (Biemiller & Boote, 2006; Cabell, Justice, McGintyc, DeCoster, & Forston, 2015; Justice, Meier, & Walpole, 2005; Marulis & Neuman, 2010; Neuman, Wong, & Kaefter, 2017).

Although the manner in which word meaning is given during an adult's mediation to the child and its influence on learning appears to be important for learning and teaching, the literature contains only scarce reference to this aspect, especially when children with SLI are concerned. Therefore, the present study attempts to analyze the different contribution of each type of dictionary support and to examine their impact on word learning at both the receptive and the expressive level (via naming) among children with typical language development as well as among children with SLI.

1.2. Book reading as support for learning new words

Reading a book to young children is a recommended way for enriching their vocabulary. The texts in children's books, unlike everyday spoken language, include words from a higher register as well as more complex morphosyntactic structures (Mol, Bus, de Jong, & Smeets, 2008). Intervention studies, which tested word teaching that included the meaning of unfamiliar words while the book was read by a kindergarten teacher, demonstrated progress in kindergarteners' word comprehension (Biemiller & Boote, 2006; Coyne, McCoach, & Kapp, 2007). These studies indicate that repeated reading of a text and defining the meaning of unfamiliar words during the course of reading are effective for promoting kindergarteners' vocabulary. Furthermore, Rosenthal and Ehri (2008) found that exposure to the printed word combined with word meaning explanation have a positive effect on word meaning acquisition. However, few studies researched the question of whether the type of word meaning support has a differential effect on the learning of new words. This question is investigated in the current study.

1.3. Learning new words from e-books

In recent decades, children have become increasingly exposed to everyday technological platforms, both at home and in educational settings. Investigators and educators view multimedia as a possible source for supporting meaningful learning (Bus, Takacs, & Kegel, 2015; Neuman, 2013; Roskos, Brueck, & Widman, 2009). Therefore, the book used in the present study incorporates the multimedia effects discussed by Mayer (2003), by voicing the meaning and simultaneously projecting a visual image that represents the target word. This is implemented by including an animated image to provide support for learning the new words, and by supplying the meaning of a new word using a parallel and common everyday word. (See Korat, Levin, Atishkin, & Turgeman, 2014 for previous research). An e-book reading activity is usually designed to be used independently. In this situation, the software serves as the mediating factor (replacing a more skilled person) especially for young children.

The contribution of e-books to supporting language and literacy among young children has been the focus of research for the past two decades. The use of an e-book that takes the child's development into account is based on existing knowledge regarding joint

adult-child reading (Korat, Klein, & Drori-Segal, 2007). For example, an e-book that contains a built-in dictionary mediates the meaning of an unfamiliar word in a manner similar to the mediation that an adult can offer (Korat & Shamir, 2007). Studies which tested the effectiveness of the e-book in supporting the learning of new words using a dictionary (that automatically presents the meaning of unfamiliar words) indicate that reading the book three to five times supports the understanding of new words, compared to reading an e-book without a dictionary or compared to the regular kindergarten program (Korat, Levin, Ben-Shabat, Shneur, & Bokovza, 2014; Korat, Segal-Drori, & Spielberg, 2018; Korat & Shamir, 2007; Shamir & Korat, 2015). However, to the best of our knowledge, the literature does not present studies on different types of dictionary support and their influence on the learning of new words (for an exception, see Beck & McKeown, 2007). Previous studies used one type of meaning support in e-book reading, which included a short explanation of the difficult word, including a figurative representation of the word (see Korat, Levin, Atishkin et al., 2014). The short explanation and relevant picture are presented automatically at the end of a specific screen reading by a narrator (see Materials and Procedure). Other types of explanations, for example including the story content in the word explanation, were not included. The present study was therefore conducted in order to examine the relationship between the type of dictionary support and the learning of new words.

1.4. E-books for children at-risk

Educators who engage in the support of children at-risk for learning disabilities use different types of programs, including technological aids (Margalit, 2000). Research has indicated the effectiveness of the e-book in supporting the learning of new words at the receptive level for children at-risk for a learning disability with (Korat, Levin, Ben-Shabat et al., 2014; Korat & Shamir, 2007, 2011; Shamir & Korat, 2015) or without the printed text (Bus et al., 2015). Studies using printed text indicate that six readings of an e-book with a dictionary advanced receptive word learning among kindergarteners at-risk for learning disability more than among kindergarteners with TLD (Shamir & Korat, 2015). It was further found that reading an e-book supported the learning of new words more than the typical kindergarten reading activities or reading a printed book with an adult's mediation (Smeets et al., 2012). Thus, the e-book specifically supports the group of children at-risk which include children with specific language impairment (DSM-5, 2013).

Children with SLI do not follow typical language development patterns, although they have intact general cognitive abilities, sensory processes and an environment that supplies sufficient opportunities. It is estimated that approximately 7% of children aged 5–6 years are diagnosed with SLI (Conti-Ramsden, Botting, & Faragher, 2001). The population of those diagnosed with SLI is considered to be heterogeneous, and includes diverse expressions of linguistic difficulties at varying degrees of severity.

Few studies have addressed the effectiveness of e-books as support for receptive word learning among children with TLD, and even fewer among children at-risk for learning disability (Korat & Shamir, 2012; Smeets et al., 2012). For example, the effectiveness of the e-book in learning new words among middle SES (Socio Economic Status) children with SLI has been examined in two experiments (Smeets et al., 2012). In the first one, two conditions were tested: working with an e-book with static illustrations (a condition similar to a printed book) versus working with an e-book with dynamic illustrations (animations intended to illustrate the meaning of difficult words). Prior to intervention, children were tested in vocabulary knowledge using the PPVT (Peabody Picture Vocabulary Test), and in knowledge of unfamiliar words from the text (verbs and nouns). The experiment included reading an e-book twice a week for 4 weeks. Results showed that children with SLI learned more new words under the various intervention conditions compared to children with TLD. The second experiment focused on children with SLI where the relationship between children's initial language level and their ability to learn new words following 8 e-book reading sessions, was tested. Prior to the intervention, measures of working memory (a phonological test via repetition of non-words, a test of repetition of numbers, a phonological awareness test), and linguistic measures (receptive test using the PPVT and an expressive test that evaluates language production through naming) were collected. Results showed that children with higher initial scores in the language tests acquired more words.

The present study aims to add to the research on the use of e-books for learning new words by examining the manner of supplying the meaning of a word, and its influence on the child's learning on different levels (receptive, expressive) in two research groups—children with TLD, and children with SLI. Previous studies already showed the progress of at-risk children in word learning after using e-books with dictionaries (from low SES families: Korat & Shamir, 2007; 2009; Korat & Shamir, 2012, from at-risk for language learning children: Shamir & Korat, 2010; Shamir & Korat, 2015) when compared to control group (reading e-book without dictionary). However, in this study we focused on word learning progress of children with SLI and children with TLD using e-books with a dictionary (without a control group that read without a dictionary). More specifically, we intend to test the impact of different types of dictionary support— a short explanation, an explanation in context, a combined explanation— on the progress of children with SLI compared to TLD in three types of words learning (receptive comprehension, word explanation and word use).

It is important to note that most studies investigated the correlations between book reading frequency and child's vocabulary, but few examined the type of explanation given by the adult to the child and its impact on word learning. Of these studies, Evans, Reynolds, Shaw, and Pursoo (2011) showed that typical English speaking parents explained approximately two words in a book reading activity to their children. They did so by providing a synonym for the difficult word (mostly done), and by providing an explanation related to the story content (less frequently done). The impact on the child's word learning was not examined. Similar findings appeared among Arabic speaking parents (Masalha, 2014) and Hebrew speaking parents (Korat et al., 2018).

The e-books used in previous studies provided word explanations using only short synonyms without any other type of explanation (Korat & Shamir, 2007, 2008). Following several studies (Shamir & Korat, 2015; Shamir, Korat, & Fellah, 2012; Shamir, Korat, & Shlafer, 2010) investigating the efficiency of the electronic dictionary, we came to the conclusion that young children may need different types of support beyond short word explanations. The design of the dictionary support, as a teaching tool, is important

to young children's language learning in general, and particularly when teaching children with SLI.

Taking the studies presented above into account, the current study included children with TLD and children with SLI, who received intervention with an e-book. The e-book included three different types of support: dictionary explanation, explanation in context, and a combination of dictionary explanation and an explanation in context. We performed a comparison between two groups (regarding word learning) as well as a comparison within groups regarding the effect of type of dictionary support. Namely, our research focuses on whether there would be differences in word learning between the two groups, and not how those who did undergo the intervention may be different than those who did not. The comparisons regarding the different types of support were conducted for each child within the group.

The comparison of the different types of support is important since we assume that new word teaching strategies by teachers and parents might be more or less effective depending on how the words are explained. Although, the literature pays attention to the importance of word learning, little research has been dedicated to whether the type of word meaning support has a differential effect on the learning of new words. This study aims to fill this gap. Using a computer system that exposes children to different types of support seemed an innovation, which could be efficient when included in e-book reading or listening. Children's word knowledge was tested before and after intervention in our study in three levels: receptive knowledge, providing a definition and word use. Thus, it makes the question of the type of dictionary support regarding each level of learning even more relevant for educational and clinical purposes. We also administered different language tests (in the phonological, semantic and syntactic fields) to the children prior to the intervention in order to evaluate whether the child's initial language level influenced the learning of new words.

1.5. Research hypotheses

The goal of present study is to examine the efficacy of e-book in an effort to promote word learning among children with SLI compared to their peers with TLD. In addition, the contributions of three types of dictionary support provided in the e-book were investigated. The three types of support included: a short explanation, an explanation in context, a combined explanation.

The first hypothesis relates to dictionary support using an e-book in which it is predicted that the support will promote new word learning among children with TLD as well as among children with SLI (Shamir & Korat, 2015; Shamir et al., 2012; Shamir et al., 2010). The second hypothesis concerns the type of dictionary support—dictionary explanation, explanation in context or a combined explanation—predicting that the combined explanation will support the learning of new words to the greatest extent (Biemiller & Boote, 2006; Penno et al., 2002). The third hypothesis relates to the initial language level of the child, which is expected to impact the learning of new words, especially among children with SLI. We predicted that children with a higher initial language proficiency level will progress in learning words more than children with a lower initial proficiency level (Smeets et al., 2012). Furthermore, we expected an interaction between the child's initial language level and the type of dictionary support especially in SLI such that children with a higher initial language would benefit most.

2. Methods

2.1. Participants

Forty children at ages 4;0-5;11 (year; months) with a mean age of 5.58 ($SD = .51$), participated in the study, as shown in Table 1. Of those, 20 were TLD children and 20 were children with SLI.

No significant differences appeared between the groups in terms of age as demonstrated in a t -test ($t(38) = .90, p = .372$) and gender as shown by the Chi-squared analysis ($X^2(1) = 2.51, p = .113$). The children attend kindergartens located in middle SES neighborhoods as defined by the Israeli Central Bureau of Statistics (2014). They are native Hebrew speakers with intact hearing and a normal IQ. Half of the children had typical language development, while the other half was enrolled in special education kindergartens after being diagnosed with language impairment (SLI) by speech language pathologists. Only children with no emotional difficulties and motor impairments were sampled in this study. The study was approved by the Bar Ilan University's IRB.

2.2. Materials and procedure

The Bridge (Yanish & Banesh, 2010), a 26-page book published in Hebrew was adapted to a digital version and used for this study. The story depicts a bear and a giant who meet on a narrow bridge and are unwilling to allow the other to cross. The characters suggest different ideas that are not appropriate for both, until they finally find an ultimate solution for both of them to cross the bridge successfully. Each page has a short text of 2–3 sentences, and a large and colorful illustration that depicts the written text. The pages were printed, scanned and then converted to the digital version in order to maintain uniformity. All screens display a static

Table 1
Children's distribution in terms of mean months of age (SD) and gender.

	TLD (N = 20)	SLI(N = 20)	
Age	67.80 (.54)	66.00 (.47)	$t = (38) = .90, p = .372$
Gender (boys:girls)	40%; 60%	35%; 65%	$X^2(1) = 2.51, p = .113$



Fig. 1. An example of word explanation in the e-book reading. Following the reading of the page, an automatic bubble is opened on the written word 'haca' (crossed) which appeared with animation of the bear crossing the bridge. At the same time the narrator says: 'haca is passed from one side to the other'.

illustration and written text. When the software is activated, the narrator reads the text and the text is synchronously lit according to the narration. Each screen has an automatic dictionary explanation for a single difficult verb which appears following the narration. An example of one of the screens is presented in Fig. 1.

Nine explicit words are explained in the dictionary. Verbs were chosen as target words since they are considered more difficult to learn than nouns (Gentner, 1981; Armon-Lotem & Berman, 2003). Previous studies using dictionaries in e-books for young children focused mainly on nouns, and this study aimed to extend our knowledge about verbs. Moreover, the animated presentation in the dictionary is especially suited for showing an action. The words were chosen following a pilot study in which two researchers read the book *The Bridge* to 24 five-year-old children in small groups (3–4 children). A 90% agreement rate was found between raters reporting which words were difficult and to what extent the words were difficult. Table 2 presents the target words included in the e-book (in English and Hebrew), the type of explanation and the narrators' explanation.

The explanation of each word in the e-book is provided in one of three ways: (a) three difficult words received a short explanation, for example, "crossed means passed from one side to the other" (b) three additional words were given an explanation within the context of the story, for example, "The bear (from the story) crossed the bridge" and finally (c) three words were defined by a combination of a short dictionary explanation and a contextual explanation, for example, "Crossed is passed from one side to the other. The bear crossed the bridge; he passed from one side to the other". Thus, the effect of the different types of dictionary support was tested within children and not only between the two groups (TLD and SLI). The same three words were presented to all children in the same manner. In all three types of dictionary support, an animation representing the meaning of the difficult word appears while the narrator provides the verbal explanation.

Table 2
Type of support, target words (English and Hebrew), and narrator's explanation.

Type of support	English	Hebrew	Narrator's explanation
Dictionary explanation			
1	Crossed	Haca	'Crossed' means passed from one side to the other.
2	Nodded	Henid	'Nodded' means moved the head in agreement.
3	Held	Axaz	'Axaz' means held.
Explanation in context			
1	Growled	Naham	Growled -the bear sounded his voice aloud.
2	Looked at	Hebit	Looked at- the giant looked at the bear.
3	Moved	Na	Moved- the giant moved on the bridge along with the bear.
Combined explanation			
1	Stood still	Nicav	'Stood still' means to stand without moving. The giant stood still on the bridge.
2	Contemplated	Hirher	'Contemplated' means thought. The giant thought how to cross the bridge.
3	Aspired to	Shaaf	'Aspired to' means wanted very much. The giant and the bear arrived at the place they wanted very much to reach.

2.2.1. Study phases

The study had three phases: pre-intervention (baseline testing), intervention, and post-intervention. The pre-intervention tests included language background testing and knowledge of the specific dictionary words during a 30-minute individual session. The intervention phase consisted of five sessions at 1–3 day intervals. The duration of reading the e-book was approximately ten minutes. The intervention was conducted in a quiet room in the kindergartens and included work in pairs which was found as effective as individual learning (Shamir, Korat, & Barbi, 2008). Children in Israeli kindergartens often work in dyads, due to teachers' pedagogical programs and/or computer shortages. The participants in all dyads knew each other and had worked together individually or in a small group with a computer as part of the kindergarten curriculum. The children were grouped into pairs based on the teacher's recommendation. Each pair was introduced to the work of "Reading with a dictionary" with the e-book and was told: "I brought you a book that you can read on the computer; you are welcome to read it, use the computer's mouse in turns, each child in his turn. When you finish reading, I will ask you some questions." Each child listened to the book with a pair of personal headphones. The post-intervention phase included tests designed to evaluate the learning of new words following the intervention phase. They were held 1–3 days after the last intervention session. The test phase (pre and post) was conducted for each child individually.

2.2.2. Language background tests

There were tests designed to assess the child's initial language level and therefore, served as background measures. Language abilities were assessed at the onset using a vocabulary test, a non-word repetition test, and a sentence repetition test. Children with SLI may exhibit impaired linguistic representations and limitations of verbal short-term memory, among other difficulties (Leonard, 2014; Marinis, 2011). Therefore, the current study used non-word repetition and sentence repetition as repetition tasks, which have been shown to tap verbal short-term memory and are reliable screening measures for assessing children with SLI (e.g., Conti-Ramsden et al., 2001) with local standards based on a sample of over 200 children ages 5;6–6;6 (Armon-Lotem & Meir, 2016).

2.2.3. Vocabulary level test - PPVT

The Peabody Picture Vocabulary (Dunn & Dunn, 1997), known in the research literature (see Smeets & Bus, 2012; Smeets et al., 2012), was used in its adapted Hebrew standardized version (Nevo & Oren, 1979). The test includes 110 items ranked according to difficulty level. For each item there are four drawings. The experimenter said the target word, and the child was asked to identify and point to the most appropriate drawing. The instruction was: "I will say a word, and you will point to the appropriate picture." Each correct answer was awarded one point. The test was stopped when six out of eight consecutive responses were wrong. The reliability of the test (α) ranges between .84–.67.

2.2.4. Non-word repetition (NWR) test

In order to assess the phonological ability to store and process a new auditory stimulus, the children were tested in a Hebrew non-word repetition test during the pre-intervention phase (Chiat, Armon-Lotem, de Jong, & Meir, 2015). The test was presented to the participants in a PowerPoint presentation format. This test consisted of 16 words. The number of syllables in the word increases with the progression of the test (from single-syllable to four-syllable words). In addition, the words are divided into words that contain a cluster (consonants without vowels between them) in different positions in the word (initial cluster or middle cluster). It should be noted that there are words similar to words that may appear in the Hebrew language and those that are not. Each participant was asked to repeat the 16 words that were said in the presentation, one word at a time. The given instruction was: "You will hear different words, repeat each word once you hear it." The participants' responses were recorded, and the score was given according to the number of errors in the word. For each phoneme the child was able to repeat, s/he was given a single point. Each substitution, omission, or phoneme addition was scored as one negative point. The reliability of this index was $\alpha = .91$.

2.2.5. Sentence repetition (SR) test

This test is intended to assess processing of the morpho-syntactic structures in a given sentence, and the reconstruction of linguistic stimuli with different lengths and syntactic complexity. This test is based on the test found in Katzenberger (2009), $\alpha = .82$ and Goralnik (1995). The assessment is intended for use by speech language pathologists to screen linguistic abilities of Hebrew-speaking children aged 4–6 years. The participant was asked to repeat eleven sentences that the experimenter said out loud. The instruction was: "I'll say a sentence, and you will repeat it after me." The length and complexity of the sentence increased as the test progressed. The participants' responses were recorded, and the score was given according to the number of errors in the sentence, with each error subtracting half a point from the test score. For example, for the sentence "Danny is disguised as a naughty monkey" the maximum score is 2. The maximum score in this tool is 22 (eleven sentences with maximum scores of two points per trial). The reliability of this index was $\alpha = .95$.

2.2.6. Pre and post tests

There were tests that focused on the target dictionary words that appeared in the e-book dictionary and therefore, were conducted pre and post intervention. The dictionary words were assessed using a receptive test (a retrieval test) and an expressive test (a word definition test) pre and post intervention in order to assess the efficacy of dictionary support. These tests are not standardized, but they have been used in previous studies (Korat & Shamir, 2007; Korat, Levin, Atishkin et al., 2014; Shamir & Korat, 2015). The tests are presented in the order in which they were conducted.

2.2.7. Dictionary words - receptive understanding test

In this test, the participant was asked to point to one of four illustrations, which represented the word he or she heard. The child was told: "I'll show you some pictures and I'll tell you a word, please choose the picture that is most suitable for the word." The test included all nine target words that appeared in the e-book. This test required that participants point to the correct image. The scores for *The Bridge* ranged from 0 to 9 points (see Korat, Levin, Atishkin et al. (2014) for a similar design). The reliability of this index was $\alpha = .66$.

2.2.8. Dictionary words – definition test

The participant was asked to explain the meaning of the target words that appear in the e-book's dictionary. The child was told: "Now we'll play with a game of words. I'll tell you a word and you'll tell me what it means, explain the word to me please." The coding of the defined words was based on the children's responses. The children's responses were ranked on a scale from 0 to 4 such that we asked the child, "What does 'look' mean?" A score of 0 was given when the child said "I do not know" or gave the wrong answer. A score of 1 was given when the child gave the wrong definition and provided a similar word for the target word or a rhyme. A score of 2 is given when the child did not give a defining word but used the target word in a proper context. For example, the child said, "The giant looked at the bear." A score of 3 was given when the child used a synonym for the target word or explained it within the context. For example, the child said, "Look - the one you see." A score of 4 (the highest) was given when the word was defined correctly as in the e-book's dictionary. For example, the child said, "Look-it saw." The total score for this part is 36 and children's scores could range from 0 to 36 points. The reliability index was $\alpha = .79$.

2.2.9. Use of dictionary words test

This expressive test, which was designed specifically for this study, was conducted first to avoid the effect of priming on the other expressive tests which followed. The child was presented with pictures representing the words which were considered as difficult words in the story and was asked to name them. "Now, I'll show you pictures of things from the book and you'll tell me what you see in the picture". The score for each word ranged from 0-2. The grade range was 0–18 (there are 9 target words). For example, for the word "gazed" (in Hebrew "hebit"), the retrieval of a semantic distant word (e.g., "smell") or "I don't know" received 0 points. Retrieval of a close semantic word (e.g., "looked") which is used more in the oral "everyday" register was given 1 point. Retrieval of the word "gazed" that appeared as a target work in the book awarded the child with 2 points. The reliability of this index was $\alpha = .75$.

2.3. Analysis

Linguistic background scores (PPVT, SR, NWR and total phonemes in NWR) were measured for the two groups using *t*-test analysis. The scores of the sentence repetition test were standardized for the range 1-100. Since this measure includes the values 0, 1 and 2, the scores were multiplied by 50 for the sake of clarity.

With regards to the first research question, a two-way ANOVA with repeated measures was conducted in order to examine the expected progress of the two groups (TLD and SLI) following the use of the e-book with dictionary support for each of the dependent variables- receptive comprehension, word explanation and word use- while controlling for the children's initial level. The outcome measure was post test performance. For the second research question focusing on the contribution of each type of dictionary support (dictionary explanation, explanation in context or a combined explanation), a repeated measures analysis of covariance model was used, in which we tested both the repeated effect of type of dictionary support and the group effect (TLD versus SLI), subject to the initial level of performance as covariate. For the third research question, we used a two-step hierarchical regression analysis to examine the contribution of: (1) type of dictionary support and (2) children's initial levels. Dependent variables are receptive comprehension, word explanation and word use.

3. Results

Table 3 presents the mean scores of the measures with their *SDs*, including *t*-test results comparing children with TLD and children with SLI in the pre-test condition. As expected, significant differences were found between the two groups in PPVT ($t = 5.25, p < .001$) in which children with TLD ($M = 69.85, SD = 10.38$) scored higher than their peers with SLI ($M = 53.4, SD = 9.4$). Similarly, the performance was better in sentence repetition ($t = 6.00, p < .001$) between TLD ($M = 20.4, SD = 1.15$) and SLI ($M = 11.85, SD = 6.25$), in non-word repetition ($t = 3.70, p < .001$) between TLD ($M = 13.55, SD = 2.23$) and SLI ($M = 10.1, SD = 3.55$), and finally in total phonemes uttered in non-word repetition ($t = 3.44, p = .002$) between TLD ($M = 104.95, SD = 2.4$) and SLI ($M = 98.35, SD = 8.2$).

Table 3
Mean (SD) linguistic scores on PPVT, SR, NWR and total phonemes in NWR.

	TLD Mean (SD)	SLI Mean (SD)	<i>t</i>	<i>p</i>
PPVT	69.85 (10.38)	53.40 (9.40)	5.25	$p < .001$
Sentence Repetition	20.40 (1.15)	11.85 (6.25)	6.00	$p < .001$
Non-word Repetition	13.55 (2.23)	10.10 (3.55)	3.70	$p < .001$
Total phonemes in NWR	104.95 (2.40)	98.35 (8.20)	3.44	$p = .002$

Table 4
Pre and post-performance on the receptive knowledge, word explanation and target word use.

	Pre	Post	Change	Group	Time	Group X Time
Receptive knowledge						
TLD	35.00 (16.02)	53.75 (21.5)	18.75 (21.65)	$F = 2.20$	$F = 28.01$	$F = .27$
SLI	35.00 (20.11)	48.12 (31.75)	13.12 (16.95)	$\eta_p^2 = .06$ $p = .146$	$\eta_p^2 = .43$ $p < .001$	$\eta_p^2 = .01$ $p = .605$
Word definition						
TLD	27.81 (16.66)	53.75 (22.16)	25.94 (11.73)	$F = 11.74$	$F = 50.37$	$F = 1.23$
SLI	5.94 (7.16)	18.12 (15.30)	12.18 (20.90)	$\eta_p^2 = .24$ $p = .002$	$\eta_p^2 = .58$ $p < .001$	$\eta_p^2 = .03$ $p = .274$
Word use						
TLD	23.57 (9.01)	31.79 (9.96)	8.21 (9.35)	$F = 18.15$	$F = 9.19$	$F = 7.77$
SLI	11.43 (8.79)	12.14 (12.06)	.71 (9.53)	$\eta_p^2 = .33$ $p < .001$	$\eta_p^2 = .20$ $p = .004$	$\eta_p^2 = .17$ $p = .008$

3.1. Dictionary support in e-book

Table 4 shows the results of the two-way ANOVAs assessing the impact of the intervention on each dependent variable (receptive comprehension, word definition, and word use) while controlling for the children’s initial level. The three measures (PPVT, NWR and SR) for initial language levels were transformed to standardized scores and the average standardized score formed a single score. The reliability of this index was $\alpha = .81$. The covariate of initial language level was significant only when the receptive test was administered such that $F(1,37) = 6.19, \eta_p^2 = .14, p = .017$.

In all three analyses, time had a significant effect. Post-test scores were significantly higher than pre-test scores in the receptive test, $F(1,37) = 28.01, \eta^2 = .43, p < .001$, word explanation $F(1,37) = 50.37, \eta^2 = .58, p < .001$, and word use, $F(1,37) = 9.19, \eta^2 = .33, p = .004$. Significant results were also found for group such that the scores of children with TLD were higher than their peers with SLI on word explanation, $F(1,37) = 11.73, \eta^2 = .24, p = .002$, and word use, $F(1,37) = 18.15, \eta^2 = .33, p < .001$. An interaction between Time X Group was found only for the word use measure, $F(1,37) = 7.77, \eta^2 = .17, p = .008$. As seen in Fig. 2, children with TLD (Mean Change = 8.21) showed more improvement in word use post-intervention compared to children with SLI (Mean Change = .71, $p < .001$). A posthoc Bonferroni analysis revealed that TLD performed significantly better after intervention ($p < .001$) than before intervention with no significant differences between pre and post intervention for children with SLI. These results are different for the receptive and word explanation tests in which both groups progressed similarly.

3.2. Type of dictionary support in e-book

Table 5 presents the repeated effect of type of dictionary support (dictionary explanation; explanation in context; combined explanation) and the group effect (TLD versus SLI), subject to the initial level of performance as a covariate. Table 5 reports marginal means for each sub-group across the three dictionary support types. The independent factor is group. The different types of dictionary support were expected to correlate with each other, as they were repeatedly measured within the same respondents.

The results show that group effect did not explain the three dependent variables: receptive test $F = .56, \eta_p^2 = .02, p = .459$; word definition $F = 1.93, \eta_p^2 = .05, p = .179$, and word use $F = 1.00, \eta_p^2 = .03, p = .324$. The type of dictionary support differed when asked to define a word and when asked to use the word ($F = 5.44, \eta_p^2 = .13, p = .006$; $F = 6.04, \eta_p^2 = .14, p = .004$; respectively) in the three repeats. A post hoc pairwise analysis with Bonferroni correction revealed that in terms of word definition, combined explanation was significantly lower ($M = 11.67$) than explanation in context ($M = 25.83, p < .001$). Combined explanation

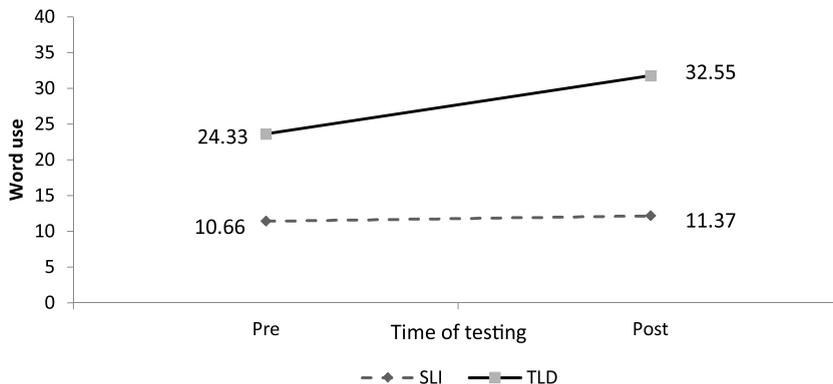


Fig. 2. Word use measure pre and post testing for children with TLD and their peers with SLI.

Table 5

Effect of type of dictionary support (dictionary explanation; explanation in context; combined explanation) and the group effect (TLD versus SLI).

Type of dictionary support					ANCOVA Results		
	Dictionary explanation	Explanation in context	Combined explanation	Total	Group	Type	GroupXType
Receptive Test							
TLD	13.93 (25.36)	14.95 (27.09)	12.70 (41.15)	13.86 (12.71)	$F = .56$	$F = .90$	$F = .32$
SLI	27.74 (18.34)	20.05 (36.51)	10.63 (27.09)	19.48 (21.05)	$\eta_p^2 = .02$	$\eta_p^2 = .02$	$\eta_p^2 = .01$
Total	20.83 (22.25)	17.50 (31.83)	11.66 (34.40)	16.67 (16.88)	$p = .459$	$p = .412$	$p = .730$
Word definition							
TLD	24.90 (25.52)	33.86 (29.42)	13.81 (28.61)	24.19 (21.12)	$F = 1.93$	$F = 5.44$	$F = .46$
SLI	13.43 (17.33)	17.81 (18.65)	9.52 (11.34)	13.58 (10.58)	$\eta_p^2 = .05$	$\eta_p^2 = .13$	$\eta_p^2 = .01$
Total	19.17 (23.13)	25.83 (26.67)	11.67 (22.07)	18.89 (18.40)	$p = .179$	$p = .006$	$p = .636$
Word use							
TLD	7.85 (14.71)	7.15 (16.58)	10.84 (9.79)	8.61 (8.51)	$F = 1.00$	$F = 6.04$	$F = 4.37$
SLI	16.32 (17.50)	1.19 (15.19)	-5.01 (10.81)	4.17 (11.00)	$\eta_p^2 = .03$	$\eta_p^2 = .14$	$\eta_p^2 = .11$
Total	12.08 (16.87)	4.17 (15.90)	2.92 (2.92)	6.39 (9.71)	$p = .324$	$p = .004$	$p = .016$

($M = 11.67$) and dictionary explanation ($M = 19.17$) did not differ significantly ($p = .405$), nor did dictionary explanation ($M = 19.17$) and explanation in context ($M = 25.83$, $p = .378$).

In word use, explanation in context ($M = 4.17$) differed from dictionary explanation ($M = 12.08$, $p = .034$) and combined explanation ($M = 2.92$, $p = .010$). As group effect was found insignificant $F = 1.00$, $p = .324$, $\eta_p^2 = .03$, the source of the interaction between types of dictionary explanation and group in word use as the dependent variable, was assigned to the differences between dictionary types in the SLI group. A change in dictionary explanation was found higher in comparison to change in explanation in context ($M = 16.32$ vs. $M = 1.19$, $p = .034$) and combined explanation ($M = 16.32$ vs. $M = -5.01$, $p = .010$) for children with SLI, whereas types of dictionary explanation were similar within the TLD group.

3.3. Type of dictionary support and initial language level

Moreover, to test our third hypothesis, we examined how the type of dictionary support and the child's initial language level impacted children's new word learning. Hierarchical regressions were used to examine the contribution of improvement following (1) dictionary explanation only; (2) explanation in context; (3) combined dictionary explanation. Dependent variables were receptive comprehension, word explanation and word use. The hierarchical regressions are presented in Table 6.

Table 6 shows that significant differences were found only with regards to combined dictionary in measuring improvement in word use. Significant effect was found for Group (TLD vs. SLI) ($\beta = .76$, $p = .002$) and for Initial level ($\beta = -.66$, $p = .002$). Namely, beyond the advantage of the TLD children compared to SLI in word use, children at lower initial levels improved more than those in higher initial level in word use, when they received the combined explanation as dictionary support. Furthermore, a significant interaction between Group and Initial level (using PROCESS, see Hayes & Preacher, 2013) was found, as seen in Fig. 3, when the combined explanation support was provided in child word explanation ($\beta = .58$, $p = .038$).

Fig. 3 shows that in SLI children no relationships were found between their Initial language level and their improvement in word explanation ($\beta = -.89$, $t = -.14$, $p = .892$). Namely, children with SLI improved consistently with no relation to their initial level. On the other hand, among children with TLD, positive relations were found between their initial language level and the improvement in word explanation of target words that were explained via a combined dictionary explanation ($\beta = 32.84$, $t = 2.30$, $p = .027$). Among children with TLD with an initial low level, a negative improvement was found (-32.69), while children with TLD with an initial high level showed positive improvement (24.23). This means that when the combined explanation was provided, the higher the extent of the initial level among children with TLD, the higher the child's ability was to explain difficult words.

4. Discussion

The present study aimed to examine whether the type of dictionary support, in the form of dictionary explanation, explanation within a context, or a combined explanation, has an impact on new word learning using an e-book among children with SLI and children with TLD. Children's knowledge was measured by receptive word knowledge, word explanation and use of target words prior to the intervention. We also investigated whether the children's initial language level will be associated with their learning.

4.1. Dictionary support in e-book

A significant improvement in new word learning following the e-book reading was found in all the three dependent measures in both children's groups. It is important to note that the progress in children with SLI was significant, but still the growth was smaller than in the case of children with TLD as predicted by the Matthew effect in which the rich get richer (Stanovich, 1986). The results showing that both children with SLI and TLD progressed in receptive learning, and word definition and even word use are compatible

Table 6
Hierarchical regressions for contribution of improvement following dictionary explanation, explanation in context and combined explanation.

Dictionary explanation												
Target words	Step 1							Step 2				
	Group	p	Initial level	p	R ²	F	p	Initial level X Group	p	ΔR ²	F	p
Receptive Test	-.31	.183	.17	.460	.05	.97	.385	.44	.125	.06	1.50	.231
Word Definition	.25	.260	.16	.478	.14	3.13	.055	-.25	.360	.02	2.37	.087
Word Use	-.25	.264	-.01	.664	.11	2.29	.115	.28	.315	.02	1.88	.151

Explanation in context												
Variables	Step 1							Step 2				
	Group	p	Initial level	p	R ²	F	p	Initial level X Group	p	ΔR ²	F	p
Receptive Test	-.08	.728	.29	.210	.06	1.15	.326	.28	.324	.02	1.10	.360
Word Definition	.30	.165	.15	.497	.18	4.05	.026	.23	.384	.02	2.94	.046
Word Use	.19	.424	-.04	.858	.03	.49	.612	.10	.743	.00	.36	.782

Combined explanation												
Variables	Step 1							Step 2				
	Group	p	Initial level	p	R ²	F	p	Initial level X Group	p	ΔR ²	F	p
Receptive Test	.03	.897	.22	.334	.06	1.21	.310	.30	.288	.03	1.19	.324
Word Definition	.10	.670	.18	.434	.07	1.35	.270	.57	.038	.11	2.53	.072
Word Use	.76	.001	-.66	.002	.29	7.46	.002	-.25	.314	.02	5.33	.004

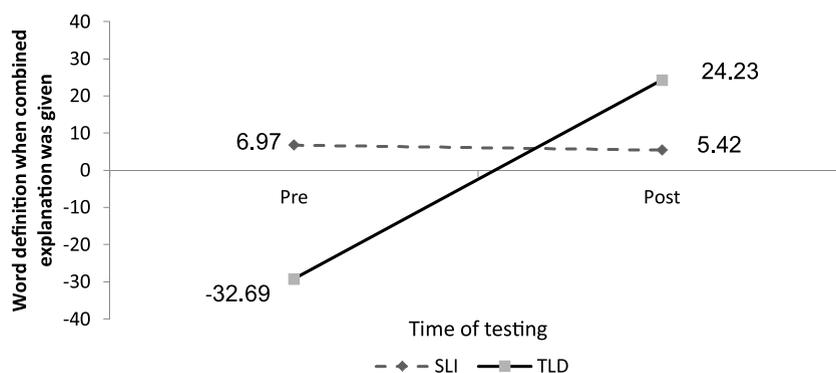


Fig. 3. Word definition when combined explanation was given and initial level was considered.

with the hypothesis regarding the contribution of the e-book to learning new words among young children (Smeets & Bus, 2014). Previous studies (which focused on e-book with children with SLI) used animations that appeared on the whole screen to demonstrate text meaning (Smeets et al., 2012). In our study, we focused on specific difficult words by using animations and spoken word meaning support. The children learned new words in both conditions. However, the intervention in the current research shows that children learned new words receptively and expressively (Kan & Windsor, 2010) following all three types of dictionary support (dictionary explanation, explanation within a context or a combined explanation). The results seem quite impressive, since these word explanations are cognitively demanding. As the first hypothesis suggests, word learning occurred. The question that remains is which type of intervention brought about this desired improvement. First, we used a direct dictionary explanation for the word meaning combined with the story content. Second, we used the dual code effect (Pavio, 1986) via the auditory route (the narrator reading) and the visual route (static and dynamic visuals). The third way was to provide the child with the definition of the word and then its use in context. This provided a better opportunity for the child to hold onto the information. No other irrelevant distracting multimedia additions were included (e.g., figures which are not part of the original story content) as is the case in commercial e-books (deJong & Bus, 2003). It is important to note that repeated reading is important for vocabulary enrichment (De Temple & Snow, 2003; Sénéchal, 1997) and therefore, five sessions of e-book reading, which included word meaning were provided.

In the case of word use, children with TLD progressed between pre and post intervention unlike children with SLI which did not

show significant gains. These results indicate that it is more difficult to use words, as was hypothesised, compared to receptive knowledge and word explanation. Receptive knowledge is relatively easier since children have to choose the right answer from an array of given pictures. Furthermore, word explanation was provided by the dictionary in the software, thus children had to remember the explanation and repeat when asked. Using new words in the context of storytelling is a more demanding task that requires retrieval and extraction processes, which are especially difficult for children with SLI (see similar results in Kan & Windsor, 2010).

4.2. Type of dictionary support

While the results showed no significant effect of the children's group (TLD compare to SLI) regarding progress, the type of dictionary support involved differences. Explanations in context were more effective than the combined explanation for children in word definition. Providing an explanation of words in the story context ultimately supported the child's ability to explain the new target words better than in other types of dictionary support. These results might show that young children need support, which is beyond the short word explanation. Providing the meaning in the story context can help the child connect her understanding to a concrete and specific situation that appears in the story content and explain it better when asked.

Dictionary explanation support was better than the other two types of support in word use for children with SLI. Word use was the most difficult task for all children, but in particular for children with SLI. However, when these children received the simple dictionary explanation it helped them learn to use the new words to the greatest extent. This learning process worked best for them due to specific support which is in line with other studies of children at-risk for learning difficulties and those from low SES backgrounds (Bus et al., 2015), including children with SLI (Smeets et al., 2012). Furthermore, the explanations were given with simple words (dictionary) and related to the task content. It may be that focusing on the dictionary explanation only, without adding other contextual features works best in the most difficult task. This hypothesis needs further corroboration.

The types of dictionary support did not affect receptive word learning. This may be due to the relative ease of the test as opposed to the two productive tasks which required the child to define the target words and to name them in context.

4.3. Type of dictionary support and initial language level

In an attempt to address our third hypothesis, we found that the combined explanation worked for all children (TLD and SLI) in learning to use new words when their initial language level was considered. Furthermore, the combined explanations assisted children with TLD children at higher initial language levels in explaining new words. These results are not in line with our hypothesis. The different type of explanation worked well especially for higher levels of learning- learning to explain new words and learning to use these words.

4.4. Limitations and future research

The limitations of the present study include the design which had two experimental groups: children with TLD and children with SLI without a control group that did not take part in the intervention. Although we focused on the three types of dictionary support in these two groups, using a third group as a control could have provided us with information regarding the effect of dictionary support compared to no support. In addition, a greater sample size as well as a longer list of vocabulary words could have strengthened the results. Recruiting children with SLI can be challenging, yet learning more about these children is of utmost importance since children with SLI may show that different specifications (e.g., type of support) should be taken into account. Using a variety of e-books, which include more diverse vocabulary, may show stronger results. Finally, the present e-book included text highlighting in parallel to the narrators' text reading, thus we did not control this effect on child's word learning. We suggest that these limitations be taken under consideration in future studies.

4.5. Conclusions

The main findings of this study illustrate that both children with SLI and children with TLD benefit from e-book reading, and can learn new words at different levels when the e-book is well designed. The study emphasizes that e-books with dictionaries that provide animated representation and stimulating oral explanations work well for word learning for TLD children as well as for children with SLI. The study also shows that the type of support is an issue that educators should pay attention to, keeping in mind that providing word meaning in context has potential to support word learning in general, and expressive word learning in particular. Furthermore, children's initial language level is important to consider when targeting words in teaching and learning. Based on the study results, e-book designers are encouraged to enrich their e-books with language support tools and offer rich options for children at different levels.

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