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The challenge and the opportunity of lexical inferencing in language minority students

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Abstract Lexical inferencing from text is a powerful tool for vocabulary and reading comprehension enhancement. Lexical inferencing relies on the pre-requisite skills of reading and existing vocabulary, and is also linked to non-verbal inferencing abilities and reading comprehension. In this study, we examined whether Fifth-grade Russian-speaking language minority (LM) students might exhibit reduced lexical inferencing abilities in comparison to their native Hebrew-speaking (NH) peers, due to their reduced proficiency in the societal language. Participants completed a measure of lexical inferencing during text reading, and measures of underlying skills, including vocabulary, word reading accuracy, reading comprehension and non-verbal inferencing. As a group, LM students demonstrated comparable lexical inferencing abilities to those of their NH peers despite significantly lower vocabulary knowledge in vocabulary. Two explanations are suggested; first, although LM students had reduced vocabulary, they were nonetheless above the vocabulary threshold required for text comprehension. Second, the regression analyses revealed that non-verbal inferencing explained unique variance only in the LM group, demonstrating that they recruited language-external resources to support lexical inferencing. The current results show that lexical inferencing can serve as a powerful tool for promoting reading comprehension and vocabulary, domains that are points of weakness for language minority students.

Keywords Language minority · Lexical inferencing · Reading comprehension · Vocabulary

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Introduction

When readers encounter an unfamiliar word during text reading, there is an opportunity for them to engage in lexical inferencing, namely to try to deduce the meaning of this word from the context. Such inferencing can support the ongoing comprehension of the current text, and over time may also expand the vocabulary knowledge of the reader. Indeed, research on children acquiring literacy in their native language (L1) has shown that lexical inferencing from context is important for comprehension and vocabulary development (Cain, Oakhill, & Bryant, 2004; Cain, Oakhill, & Elbro, 2003; Ricketts, Bishop, Pimperton, & Nation, 2011). Less is known, however, about the lexical inferencing abilities of language minority children immersed in a societal-language educational setting, who often have lower vocabulary knowledge and reading comprehension abilities in their L2 than their native speaking peers (August & Shanahan, 2006; Lesaux, Crosson, Kieffer, & Pierce, 2010; Melby-Lervåg & Lervåg, 2014). For these students, lexical inferencing could be a powerful mechanism for narrowing these gaps and supporting literacy and academic achievements. At the same time, lexical inferencing might pose a special challenge for language minority children, because of their lower proficiency in the societal language. In the current study, we address this question by directly comparing the lexical inferencing abilities of language minority and native speaking elementary school children. Further, we investigate which pre-requisite and higher-order underlying skills support lexical inferencing in these two groups.

When reading an unfamiliar word, the reader may use linguistic cues from the word itself, or from the surrounding context, and combine these with previous knowledge, to generate an inference about the meaning of the unfamiliar word (Haastrup, 1991; Landauer & Dumais, 1997; Sternberg, 1987; Wesche & Paribakht, 2009). Over time, repeated exposure to the word in different contexts may enhance its orthographic and morphological mental representations and elaborate its syntactic and semantic relations with other words (De Bot, Paribakht, & Wesche, 1997; Elgort, Perfetti, Rickles, & Stafura, 2015; Ricketts et al., 2011). Thus, lexical inferencing is one avenue for growing vocabulary knowledge. Components of vocabulary can include depth and breadth of knowledge, receptive and productive knowledge and lexical quality that relates also to orthographic, syntactic and morphological aspects of word knowledge (Henriksen, 1999; Laufer & Goldstein, 2004; McKeown, 2014; Perfetti, 2007). In the current study, we operationalized vocabulary knowledge as vocabulary breadth (the number of known word meaning), as measured by a productive task.

In addition to expanding vocabulary knowledge, appropriate lexical inferencing may also enhance text comprehension. Successful lexical inferencing allows the reader to construct a well-integrated and coherent representation of the meaning of the context in which the inferred word is embedded and therefore, promotes overall text comprehension. Furthermore, since the relations between reading comprehension and lexical inferencing are reciprocal, good understanding of text concurrently

promotes the ability to infer the meaning of an unknown word (Cain et al., 2004; Wesche & Paribakht, 2009).

Lexical inferencing is a complex literacy process, and as such relies on both lower and higher-order skills, similar to reading comprehension itself. As suggested by the simple view of reading (Gough & Tunmer, 1986; Hoover & Gough, 1990), the basic pre-requisites for reading comprehension are decoding and language comprehension. Language comprehension itself is a complex structure, and in various studies has been measured as grammatical knowledge (Geva, & Massey-Garrison, 2013; Shiotsu & Weir, 2007) or as vocabulary knowledge (Prior, Goldina, Shany, Geva, & Katzir, 2014). We suggest that lexical inferencing fundamentally relies on the same pre-requisites as reading comprehension more generally (Prior et al., 2014), and a threshold in these pre-requisites must be met to allow for successful inferencing. Beyond these lower level skills, lexical inferencing might also recruit general inferencing abilities and strategies, as suggested by more complex models of reading comprehension (RAND Reading Study Group, 2002). In the current study, we examine the contribution of the pre-requisite skills to lexical inferencing, as well as the additional contribution of higher-order skills.

Lexical inferencing in L1 children

Typically developing children learn around 3000 new words every year (Cain et al., 2003; Nagy & Anderson, 1984), from various sources such as oral communication, reading and digital media (Oetting, Rice, & Swank, 1995; Takacs, Swart, & Bus, 2015; Webb, 2010). Once children master decoding in their native language (L1), a large proportion of new words are encountered by exposure to written texts, and reading becomes a central avenue for vocabulary growth (Nagy, Herman, & Anderson, 1985; Sternberg, 1987). The majority of these words are acquired by incidental learning from written text, namely lexical inferencing (Jenkins & Dixon, 1983; Nagy et al., 1985).

Lexical inferencing is, as mentioned above, a complex skill, which relies on basic pre-requisite skills. Indeed, studies among elementary school children (between ages 7 and 12) have found positive correlations between lexical inferencing, and the pre-requisite skills that support it. Thus, higher levels of vocabulary knowledge and basic reading ability (e.g. word reading accuracy) were associated with better lexical inferencing performance among L1 children (Geva, Galili, Katzir, & Shany, 2017; Ricketts et al., 2011; Shefelbine, 1990). Similarly, positive correlations have also been reported between lexical inferencing and higher-order skills, including non-verbal inferencing ability (Ricketts et al., 2011) and reading comprehension (Cain et al., 2004; Geva et al., 2017; Shefelbine, 1990). Children with weak reading comprehension skills are less able to infer the meaning of novel words from context than their skilled peers (Cain et al., 2003, 2004; Swanborn & De Glopper, 2002). This weakness in lexical inferencing can be understood as part of a general difficulty in generating a range of inferences necessary for reading comprehension (Cain, Oakhill, Barnes, & Bryant, 2001; Nation, 2005).

It is important to note that lexical inferencing is a complex process and is impacted by individual differences on other abilities such as working memory and

strategy use (Cain et al., 2004; McKeown, 1985). However, in the current study, we focus on the pre-requisites of vocabulary and decoding, as well as the higher-order skills of general inferencing ability and reading comprehension. This choice is motivated by the vast literature identifying vocabulary and reading comprehension, which are both highly important for lexical inferencing, as potential weakness points among language minority learners.

Lexical inferencing in L2 adults

Lexical inferencing has also been identified as important for supporting vocabulary growth in adults learning an L2 (Elgort et al., 2015; Haastrup, 1991; Wesche & Paribakht, 2009). As has been found for L1 speaking children, lexical inferencing abilities have been linked to existing vocabulary knowledge and reading comprehension skills in L2 adults (Bengeleil & Paribakht, 2004; Elgort et al., 2015; Elgort & Warren, 2014; Pulido, 2007; Wesche & Paribakht, 2009). Most of the literature on L2 adults has focused on how language proficiency modulates lexical inferencing abilities. Thus, readers with more developed L2 vocabulary knowledge are more successful in inferring the meaning of unfamiliar words from incidental context. Further, readers with fewer and weaker L2 lexical representations encounter difficulties in integrating the meaning of the unknown word into the insufficiently developed L2 network, resulting in ineffective lexical inferencing (Elgort et al., 2015; Nassaji, 2006; Pulido, 2007).

Emphasizing the importance of language proficiency for lexical inferencing among adults, studies consistently show a marked advantage for L1 over L2 readers (Elgort et al., 2015; Wesche & Paribakht, 2009). This L1 advantage appears to be related to L1 readers' more efficient language processing skills that include lexical and morpho-syntactic knowledge.

Specifically, previous research has shown that efficient lexical inferencing requires a threshold level of vocabulary knowledge as a basic condition. A reader is estimated to need to know a minimum of 95–98% of the specific vocabulary in a given text in order to be able to successfully infer the meaning of unfamiliar words (Hsueh-Chao & Nation, 2000; Laufer, 1989; Nation, 2006; Schmitt, Jiang, & Grabe, 2011). This vocabulary threshold is highly relevant for both L1 and L2 readers, but in the L2 setting it is more common that the reader might not reach this necessary threshold, which in turn limits the possibility of successful lexical inferencing.

Lexical inferencing in language minority children

Over the last 2 decades, the population of language minority learners has attracted the attention of researchers, educators and policy makers, because of the growing numbers of language minority children immersed in educational systems world-wide (August & Shanahan, 2006; Geva & Wiener, 2015). Language minority children are children who immigrated themselves or are second-generation immigrants and speak a home language that differs from the societal language. This population differs from L2 learners in foreign language settings because they are immersed in the L1 societal language in many aspects of everyday life including

at school. Therefore, specific targeted research is necessary to reach a full understanding of this population.

Of relevance, language minority students often display gaps from their monolingual peers in literacy skills, and therefore require special pedagogic attention (Geva & Wiener, 2015; Lesaux & Kieffer, 2010; Lesaux, Koda, Siegel, & Shanahan, 2006; Pasquarella, Gottardo, & Grant, 2012; Spencer & Wagner, 2017). However, the specific issue of lexical inferencing in this population has received only scant attention in the literature (Prior et al., 2014).

The opportunity

As described above, lexical inferencing ability is of particular importance for language minority readers as a tool for developing vocabulary and reading comprehension in the L2. Since language minority children distribute their language learning time across two languages, they often have smaller L2 vocabularies than their native speaking peers (Bialystok, Luk, Peets, & Yang, 2010; Oller, Pearson, & Cobo-Lewis, 2007). For this specific reason, incidental learning during text reading can serve as an important opportunity for vocabulary growth. Indeed, among native speaking children, avid readers accrue considerably more lexical knowledge each year than their less well-read peers (Cunningham & Stanovich, 1991; Stanovich, 1986). Written language is lexically richer than spoken language and may therefore provide a greater number of learning opportunities than is available in spoken context, especially in the case of language minority learners who have reduced exposure to the spoken societal language.

The challenge

As noted above, lexical inferencing is tightly linked to existing vocabulary knowledge and reading comprehension, both of which have been identified as areas of weakness for language minority learners. Specifically, language minority learners from diverse languages and backgrounds have lower reading comprehension performance than their native speaking peers (Droop & Verhoeven, 2003; Lesaux et al., 2006; Lesaux & Kieffer, 2010; Marx & Stanat, 2011; Pasquarella et al., 2012). Part of this gap in language minority learners' reading comprehension is caused by their reduced societal language vocabulary knowledge (Geva 2006; Kieffer & Lesaux, 2012). This gap in L2 vocabulary is consistent and some studies even demonstrate that it widens over time, even as language minority students continue being immersed in societal language schools (Jean & Geva 2009). Such gaps in vocabulary have also been demonstrated for Russian-speaking language minority children in Israel, who are the targeted population in the current study (Schwartz & Katzir, 2011; Schwartz, Kozminsky, & Leikin, 2009; Walters, Armon-Lotem, Altman, Topaj, & Gagarina, 2014). Thus, lexical inferencing might pose a specific challenge for language minority children.

One previous study investigated the lexical inferencing abilities of language minority Russian speaking adolescents, immersed in Hebrew in Israel (Prior et al., 2014). This study examined adolescents who had been immersed in the societal

language for only 2 years and therefore were still acquiring language and literacy in their L2. Reinforcing previous findings from L1 children and L2 adults, the results found significant correlations between L2 reading comprehension, vocabulary and lexical inferencing ability. Further, in this study successful lexical inferencing was linked to accurate decoding skills in L2.

The current study

The lexical inferencing abilities of language minority children immersed in a societal-language educational setting have not received sufficient attention in the literature. The present study aims to fill this gap, by investigating Russian minority speaking fifth grade children in Israel, who are immersed in the societal language, Hebrew. At this grade level, reading is beyond the initial stages of acquisition and the focus is on text reading as a central skill for acquiring knowledge and expanding vocabulary.

The study addresses the following research questions. First, in light of documented gaps in vocabulary and reading comprehension, we ask whether language minority students will also show lower levels of lexical inferencing than native speaking peers. Second, to achieve a fuller understanding of the process of lexical inferencing, we examine which underlying skills children from the two language groups recruit to support successful lexical inferencing. Specifically, we investigate the possibility that language minority student may be able to recruit additional skills to support lexical inferencing in order to overcome their smaller vocabulary knowledge. This possibility stems from a recent study of reading comprehension, which showed that language minority children recruited executive function skills beyond those used by native speaking peers (Luk, Mesite, Leon, Guerrero, & Christodoulou, 2015).

Method

Participants

The study presented in this paper is part of a large research project examining language and literacy skills of Russian language minority students in Israel (Shahar-Yames & Prior, 2017). The full research sample included 114 fifth grade students from five different public elementary schools from an urban area in the north of Israel. The sample was drawn from regular classes, and students are typically developing with no sensory-motor difficulties. Fifty-six students (52% girls) reported speaking Hebrew exclusively at home and were classified as native Hebrew speakers. Fifty-eight students (65% girls) reported Russian as their native language and were initially classified as Russian-speaking minority learners. These groups are a result of convenience sampling, yet all participants were drawn from the same classrooms, from schools in similar neighborhoods with equivalent middle-low socio-economic status.

In order to identify suitable participants, letters describing the study and seeking parental approval were distributed to all fifth grade students from participating schools. The letter included basic questions about home language environment, self-rating of Hebrew and Russian oral proficiency as well as reading and writing skills in both languages, in addition to background data and language use at home. At this stage, two children who spoke languages other than Hebrew and Russian at home were excluded from the study. Children whose parents approved participation were divided into two groups.

A majority of the of the language minority students were second-generation immigrants, as 78.5% were born in Israel. One child had one Russian speaking parent and one Hebrew speaking parent, and can be considered a simultaneous bilingual with exposure to both languages from birth. All other children came from families in which both parents had emigrated from the former USSR, or from single-parent families. According to parental reports, 64% of these sequential bilinguals were exposed to Hebrew from age 2–3 years. The entire sample had attended Hebrew speaking public schools from age six, namely the first grade.

All the language minority students reported speaking Russian at home on a regular basis—half reported speaking Russian exclusively with their parents, and the rest spoke both Russian and Hebrew at home. Russian language proficiency was also assessed objectively using a Russian receptive vocabulary test administered by a native Russian speaker (a Russian translation of the Hebrew version of the Peabody Picture Vocabulary Test; Dunn, 1965; Solberg & Nevo, 1979). The average score of the language minority group was 76 correct items, out of 110 (SD = 13.54). Although the Russian version of the test is not standardized, the average score of the language minority group is roughly equivalent to the receptive vocabulary expected from 10-year-old children in the Hebrew version. We thus feel confident that although the language minority students are mostly second generation immigrants and Hebrew is the only instructional language at school, the participants have adequate oral language abilities in Russian. Finally, two students initially identified as belonging to the language minority group, but who scored more than two standard deviations below the mean of the group on the vocabulary measure were excluded from the sample, leading to a final group of 56 language minority students.

Regarding Russian literacy of the language minority students, 37% reported no ability to read and write in Russian, 32% reported basic literacy skills, and only 31% rated their Russian literacy skills as very good. Consistent with the educational policy in Israel, the public schools deliver literacy instruction only in Hebrew, so that any existing Russian literacy skills were taught either by family members or in afternoon classes.

Omitted participants

Eleven participants out of the 112 students who participated in the larger study were not able to complete the lexical inferencing task. This task was more demanding than the other experimental tasks for several reasons. First, it required children to read eight individual texts. Second, participants were required to write definitions

for the novel words. Consequently, no usable data was available from three native Hebrew speaking students and eight language minority students. Thus, the final sample analyzed in the current paper included 48 language minority students, and 53 native Hebrew speaking students. The language and literacy abilities of the excluded students were on average lower than their respective group (see "Appendix 1"). We will return to this issue in the discussion. Characteristics of the final sample are presented in Table 1.

Measures

Lexical inference from text

In order to measure the ability to infer the meaning of novel word from a written text, we used a Hebrew version (Prior et al., 2014) of the Cain et al. (2003, 2004) task. The task includes eight short narrative texts, describing common every-day situations; each text contains a made-up noun for a real and concrete object that does not have a single-word label in Hebrew or in Russian (e.g., a baby high-chair). The texts included 126 words on average, and did not include low frequency words, in order to minimize comprehension difficulties. Each target word appeared twice in the text, followed by a single filler sentence. Subsequently, supporting information about the meaning of the target word was provided in one or two sentences (see sample story translated from Hebrew to English in the "Appendix 2"). This design was used in previous studies among elementary school students and showed significant variability in lexical inferencing abilities (Cain et al., 2003, 2004).

Participants read the stories after they were given the following instructions orally: "There are a few stories that I would like you to read silently. The person who wrote them got stuck sometimes because s/he did not always find the right

Table 1 Participant characteristics

	Native Hebrew N = 53	Language Minority N = 48
Age (years; months)	11;03 (0.30)	11;06 (0.47)
Parental education		
Mother	14.6 (3.5)	13.9 (2.6)
Father	13.7 (2.1)	13.2 (2.7)
Parent self-rated language Proficiency (0–5)		
Mother's Hebrew prof.**	4.9 (.3)	3.1 (1.4)
Mother's Russian prof.**	0	4.9 (0.2)
Father's Hebrew prof.**	4.8 (.4)	2.7 (1.4)
Father's Russian prof.**	0	4.5 (1.0)

The parental questionnaire included self-rated language proficiency scales between 0 (no proficiency) to 5 (very proficient) in oral, reading and writing skills in Hebrew and Russian. An average score was calculated across all skills in each language

** Groups differed significantly ($p < .001$)

word for some things, so s/he used a funny, made-up word, instead. I want you to tell me what you think the funny word means. At the end of each story, I will ask you to write an explanation for the word meaning. For example, if I ask you what a 'bed' was, you might write that it was 'a long piece of furniture that we sleep in'."

Once the participants had finished reading each text, they were asked to write a definition for the target word. Then the response sheet was removed and a multiple-choice question was presented (orally and in writing) following the instruction: "I will show you four different explanations for the made-up word and I want you to choose the best meaning for the word according to what you read in the text. You can chose a different answer from what you wrote". Each story appeared on a separate sheet and the text remained in front of the participants so they could reread it.

Two judges scored the definitions given by the participants, based on the scoring method developed by Cain et al. (2003). Two points were given for responses where the full inference had been made (e.g. 'a high chair for babies'). As in previous studies using this task (Cain et al., 2003, 2004; Geva et al., 2017; Prior et al., 2014), one point was given to a less complete response that referred to the same semantic field but was not specific enough (e.g. 'a chair'). A score of 0 was given if the response was incorrect indicating that the participant did not manage to infer the meaning of the word (e.g. 'dinnerware'). The maximum definition score was 16 points for all eight stories. For the multiple-choice questions, the number of correct responses was calculated, for a maximum score of eight points. Internal consistency of the current study definition measure (α Cronbach) was .74. The internal consistency (α Cronbach) of the multiple-choice measure was lower ($\alpha = .54$), and therefore data and results from the multiple choice questions were not further analyzed. Instead, we limit our analyses exclusively to the definition measure.

Productive vocabulary

Hebrew vocabulary was assessed using a picture naming test (Kavé, 2006) consisting of 48 black-and-white line drawings, each referring to a Hebrew noun, presented according to descending word frequency. Participants were instructed to name each picture using one word, and the number of correct answers was calculated. Standardized scores are available for Hebrew native speaking children (Kavé, 2006). Split half reliability reported for the original test is .6 (Kavé, 2005).

Single word reading

Hebrew reading ability was assessed by using a single word reading subtest from the battery 'Reading and Writing Achievement Test: 'Alef Ad Taph' (Shany, Lachman, Shalem, Bahat & Zeiger, 2006) with standardized national norms available in Hebrew. This subtest includes 38 single words, representing various morphological structures. Words are ordered by increasing length and decreasing frequency. Participants read the words aloud. In the current study, we report accuracy as the percent of correct responses. Internal consistency reported for the original test (α Cronbach) is .85 in fourth grade (Shany et al., 2006).

Non-verbal inferencing ability

Non-verbal ability was measured by the Test of Nonverbal Intelligence-3 (Brown, Sherbenou, & Johnsen, 1982). The test includes five training items and 45 abstract/figural problem-solving items arranged in increasing order of difficulty. Items are in multiple-choice format, with either four or six options. Participants selected and marked the best option. Internal consistency for the original test is reported as between .8 and .9 (Brown, Sherbenou, & Johnsen, 1982).

Reading comprehension

Reading comprehension was measured by an adapted Hebrew version (Zeltsman-Kulick, Katzir, & Prior, 2018) of the Gray Oral Reading Test-Diagnostic (Bryant & Wiederholt, 1991). The measure includes eight texts of various lengths and different difficulty levels. Four of the texts are narrative and four are expository. Each text is followed by five multiple-choice questions, which target both factual understanding of the text and inferential understanding. Participants silently read the passages and answered the questions. Reading comprehension scores were the number of correct answers, with a maximum score of 40 points. Split-half reliability for the current study is .87.

Procedure

The current study was part of a larger project, which also investigated reading and morphological abilities of language minority learners. Participants were administered a battery of tests in February through May of fifth grade, in two testing sessions each lasting approximately 1 h. One session was administered individually and included the following tasks: lexical inferencing, productive vocabulary, and single word reading (and additional tasks not reported here). The other session was administered in a group setting of 5–8 children and included the non-verbal intelligence and reading comprehension tasks. The order of the two sessions was random, and the order of tasks within each session was fixed. All tasks were administered during school hours in a quiet room by the first author and trained graduate students from the Department of Learning Disabilities.

Results

Lexical inferencing performance by language group

The performance of the native Hebrew group and the language minority group in the lexical inferencing task is presented in Table 2.

As seen in Table 2, there were no group differences in lexical inferencing performance ($t(99) = .439$, $p = .662$). This finding indicates that both native Hebrew speaking students and language minority students were similarly able to

Table 2 Lexical inferencing performance, by language group

	Native Hebrew N = 53	Language minority N = 48
Mean (max score 16)	9.9	9.5
SD	4.3	4.2
Range	0–16	1–16

Three participants from the native Hebrew group and 1 participant from the language minority group reached a ceiling score of 16 in the lexical inferencing task

infer the meaning of unfamiliar words during text reading (for detailed information about performance in each text see Appendix 3).

Group comparisons in underlying skills

The performance of the language minority group and native Hebrew group in measures of cognition, language and reading is presented in Table 3.

A comparison between the groups on these skills reveals no significant differences in non-verbal ability ($t(98) = 1.548$, $p = .125$), demonstrating that the two groups have similar the non-verbal inferencing abilities. Similarly, both groups showed similar performance in word reading accuracy ($t(99) = 1.789$, $p = .077$). In contrast, the native Hebrew speakers named significantly more objects correctly than did the language minority children ($t(99) = 5.553$, $p < .001$, $d = 1.105$), as expected based on previous studies of language minority students' vocabulary knowledge (e.g., Bialystok et al., 2010; Farnia & Geva, 2011; Kieffer & Lesaux, 2012). Further, as seen in Table 3, native Hebrew speaking students fell within the normal range of expected productive vocabulary knowledge, whereas the average standard score of the language minority group was below the normal range.

Table 3 Experimental task performance by language group: mean (SD) and normative performance (where available)

	Native Hebrew N = 53	Language minority N = 48
Vocabulary *** (number correct, max score 48)	40.6 (3.4)	35.2 (6.1)
Standard Z score	− 0.17	− 1.5
Word reading accuracy (% correct)	88% (6.9)	85.7% (7.5)
Percentile range	35–65	25–35
Non-verbal ability test (number correct, max score 45)	25.8 (4.8)	22.2 (6.3)
Reading comprehension (number correct, max score 40)	24.2 (5.6)	21.4 (6.8)

Group differences significant at ***$p < .001$

Therefore, these students show significantly poor naming ability relative to native Hebrew speaking children their age. Finally, the native Hebrew speaking group had numerically higher scores in reading comprehension, but this difference failed to reach statistical significance $(t(110) = 1.932, p = .056)$.

Predicting lexical inferencing ability

Lexical inferencing is a high-level task, and as such is correlated with other language and literacy skills (Cain et al., 2004; Geva et al., 2017; Nassaji, 2006; Prior et al., 2014; Pulido, 2007; Ricketts et al., 2011). Similar patterns are also evident in the current study. The first order correlations between the experimental variables, collapsed for both participant groups, are presented in Table 4 (the magnitudes of correlations were similar for the two language groups; for correlations by group see Appendix 4).

As observed in previous studies, the strongest high-moderate correlation was found between reading comprehension and lexical inferencing, as both tasks seem to be measuring partially overlapping high-order literacy abilities (Cain et al., 2004; Pulido, 2007; Wesche & Paribakht, 2009). The next strongest correlation was between word reading accuracy and lexical inferencing, since reading is a basic skill that is involved in lexical inferencing during text reading. Lexical inferencing ability was also moderately and significantly correlated with non-verbal inferencing ability and vocabulary.

Next, we wished to investigate to what degree the participants in the two groups recruited the different underlying skills to support lexical inferencing. To this end, we computed two regression models, one for each participant group. Predictor variables were entered in the following order: vocabulary knowledge and word reading accuracy were entered in the first step as the pre-requisites for lexical inferencing; Non-verbal ability was entered on the second step and reading comprehension was entered as the final predictor in the model (see e.g. Cain et al., 2004; Ricketts et al., 2011; see Table 5). This order of variables was selected based on our division of pre-requisite skills and high-order skills.

The regression models revealed differences in the degree to which children from the two language groups recruited the underlying skills to support lexical inferencing. For the native Hebrew speaking children, the pre-requisite skills were the strongest predictors explaining 32% of the variance in lexical inferencing. However, only word reading accuracy was found to be a significant predictor $(p < .001)$, whereas vocabulary did not further explain variance in lexical

Table 4 Correlations among lexical inferencing and other experimental tasks for the entire sample (N = 101)

Measure	2	3	4	5
1. Vocabulary	.26*	.20*	.44***	.30**
2. Word reading accuracy		.19	.40***	.44***
3. Non-verbal ability			.23*	.31**
4. Reading comprehension				.52***
5. Lexical inferencing				

$*p < .05; **p < .005;$
$***p < .001$

Table 5 Regression analyses predicting word inferencing by language group

	Variable	Native Hebrew N = 53			Language Minority N = 48		
		R^2	ΔR^2	β	R^2	ΔR^2	β
Step 1: pre-requisites		.316	.316***		.208	.208**	
	Reading accuracy			.478***			.305*
	Vocabulary			.207			.287*
Step 2: non-verbal inferencing	TONI	.345	.029	.180	.305	.097*	.322*
Step 3: reading comprehension	GORT	.456	.111***	.370***	.389	.083*	.361*

*p < .05; **p < .01; ***p < .005

inferencing (p = .091). Non-verbal inferencing ability added 3% to the model, a non-significant contribution (p = .149). Finally, reading comprehension explained an additional 11% of the variance in lexical inferencing from text (p = .003). Overall, the regression model explained 46% of the individual differences in lexical inferencing for native Hebrew speaking children.

A different pattern emerged for the language minority students. As seen in Table 5, the pre-requisite skills were the strongest predictors, as was the case for native Hebrew speakers. However, the pre-requisite skills predicted a lower percent of variance in lexical inference (only 21%). Additionally, for this group, both vocabulary and word reading accuracy were significant predictors (p = .039, p = .029 respectively). A further divergence from the native Hebrew speakers is that for the language minority students non-verbal inferencing ability had a significant contribution (p = .017) explaining an additional 10% of the variance in lexical inferencing. Finally, reading comprehension significantly explained an additional 8% of the variance in lexical inferences (p = .020), similar to what was found for the native Hebrew speakers. Overall, the regression model for the language minority group explained 39% of the variance in lexical inferencing.

The regression models for both participant groups moderately explain variance in lexical inferencing. Given that lexical inferencing is such a complex task, it stands to reason that additional contributing factors might include cognitive variables (such as working memory and attention), motivation, previous experience and use of strategies.

Discussion

The current study examined the lexical inferencing abilities of fifth grade language minority students in comparison to their native speaking counterparts, a topic that has received only scant attention in the literature. The main finding is that the language minority students demonstrated comparable lexical inferencing abilities to those of their native Hebrew speaking peers despite lower performance in

vocabulary. We suggest two possible explanations for this finding, which are not mutually exclusive. First, the language minority students might have reached sufficient above-threshold levels of the pre-requisite skill of vocabulary knowledge, which enabled them to infer the meaning of unfamiliar words to the same degree as their native speaking counterparts. Second, we found that the language minority learners recruited non-verbal inferencing abilities to a greater extent than the native Hebrew speaking children, which might also have supported their lexical inferencing.

Lexical inferencing performance

The main finding of the current study was that the lexical inferencing abilities of the language minority students were similar to those of their native speaking peers. During text reading, both language groups were similarly able to infer the meaning of an unknown word, as measured by their ability to provide a written definition.

Underlying skills supporting lexical inferencing

The current study replicates previous findings, in that reading accuracy, vocabulary, reading comprehension and non-verbal inferencing abilities were all positively correlated with lexical inferencing (Cain et al., 2004; Elgort et al., 2015; Geva et al., 2017; Nassaji, 2006; Ricketts et al., 2011). Conceptually, reading accuracy and vocabulary can be defined as pre-requisites of lexical inferencing (Gough & Tunmer, 1986; Hoover & Gough, 1990), whereas reading comprehension and non-verbal inferencing abilities can be seen as high-order skills further recruited to support lexical inferencing.

Single word reading and vocabulary

In the current study, reading ability was a pre-requisite skill for lexical inferencing from written text as has been shown in children reading in the L1 (Geva et al., 2017; Ricketts et al., 2011) and in language minority adolescents reading in the L2 (Prior et al., 2014). These studies demonstrate that better single word reading skills were associated with greater success in lexical inferencing. This is because efficient single word reading allows the reader to allocate cognitive resources to comprehension processes and in particular to lexical inferencing (Perfetti, 2007; Perfetti, Landi, & Oakhill, 2005). In the current study, both language groups showed similar word reading levels, which were sufficient in order to support the inferencing processes.

However, in the pre-requisite skill of vocabulary the language minority students named significantly fewer objects in Hebrew than their native speaking peers; a finding that is in line with a large body of previous research (e.g., Droop & Verhoeven, 2003; Jean & Geva 2009; Kieffer & Lesaux, 2012). This gap in vocabulary was significant, although the population targeted in the current study had been immersed in the societal language, Hebrew, at least from the first grade and in most cases even before.

This group difference raises the question of how were language minority children able to achieve similar lexical inferencing performance to that of the native speaking children despite their lower vocabulary knowledge? Indeed, previous research on children's lexical inference in their native language (Cain et al., 2004; Geva et al., 2017; Ricketts et al., 2011; Shefelbine, 1990) and adults' lexical inference in an L2 (Elgort et al., 2015; Nassaji, 2006; Wesche & Paribakht, 2009) has demonstrated the significant contribution of prior vocabulary knowledge to success in lexical inferencing. According to some researchers, a reader has to reach a threshold understanding of above 95–98% of the specific text vocabulary as a basic condition for successful lexical inferencing (Laufer, 1989; Nation, 2006; Shefelbine, 1990), although comprehension and vocabulary learning may occur at lower levels as well (Schmitt et al., 2011).

In this sense, it is surprising that the language minority children in the current study demonstrated comparable lexical inferencing ability, despite having smaller vocabularies. A possible explanation is that their vocabulary was, nonetheless, above the threshold needed for understanding the specific texts used in the study, even though this was not measured directly in the current study. Indeed, the target pseudowords were embedded in texts that described familiar everyday situations and did not include low frequency words and academic vocabulary, which are especially challenging for language minority students (Geva & Wiener, 2015; Heppt, Haag, Böhme, & Stanat, 2015). These text characteristics might have allowed the language minority students to succeed in lexical inferencing. Yet, it is important to remember that many academic texts that students read in the upper elementary grades are linguistically more complex. Therefore, it is possible that under more naturalistic conditions, the language minority students may not meet the vocabulary threshold necessary for successful lexical inferencing.

Higher-order skills

In the current study, the groups were well matched in their non-verbal inferencing abilities. Previous studies reported inconclusive results about the contribution of non-verbal ability to lexical inferencing. Ricketts et al. (2011) found that among L1 children non-verbal ability was a significant predictor for success in lexical inferencing. However, non-verbal ability did not correlate with lexical inferencing in another study of L1 children (Shefelbine, 1990) and in a study of L2 adolescents (Prior et al., 2014). In the current study, there were significant first-order correlations between non-verbal and lexical inferencing abilities in both groups, but non-verbal inferencing abilities contributed significantly to lexical inferencing beyond other predictors only for the language minority children. This issue will be discussed below in further detail.

In reading comprehension, the native Hebrew speaking group achieved a numerically higher score than the language minority group, though this difference was only marginally statistically significant. This finding diverges from previous research, which often reports significantly lower reading comprehension for language minority children (for review see the meta-analysis of Melby-Lervåg & Lervåg; 2014), and may be a result of the specific measure of reading

comprehension that was used. The reading comprehension measure in the current study was a multiple-choice test, with no time limit on performance. Importantly, the meta-analysis of Melby-Lervåg & Lervåg (2014) indicated that in such multiple-choice tests there tend to be smaller differences between first- and second-language learners than in open-ended question tests. In addition, many previous studies have used timed tasks (Farnia & Geva, 2013; Kieffer & Vukovic, 2012; Lesaux & Kieffer, 2010; Pasquarella et al., 2012), which might also result in larger group differences.

However, as reported in previous studies, the first order correlations between reading comprehension and lexical inferencing were strong and significant in both groups, as both skills are complex literacy abilities that share many dimensions (Cain et al., 2004; Wesche & Paribakht, 2009).

Predicting lexical inferencing

Our hierarchical regression analyses revealed that although the two groups were well matched in their lexical inferencing performance, they relied on different skills to support this ability. Thus, both vocabulary and reading accuracy significantly explained variance in lexical inferencing in the language minority group, but only reading accuracy was a significant predictor for the native Hebrew group. We suggest that vocabulary contributed to the performance of the language minority group because the overall vocabulary performance of this group was lower and more variable. In contrast, the native Hebrew speakers were most likely well beyond the threshold vocabulary necessary for lexical inferencing in the specific texts used in this study, and thus their vocabulary knowledge did not predict their performance. In both groups, accurate word reading contributed to successful lexical inferencing, reinforcing the role of single word decoding as a pre-requisite for lexical inferencing (Prior et al., 2014).

The higher-order skill of non-verbal inferencing ability contributed to the performance of the language minority, but not the native Hebrew speaking children. Thus, in light of their lower vocabulary skills, we suggest that language minority children recruited general inferencing abilities to support lexical inferencing from text. Such recruitment of language-external resources can explain the fact that the language minority students showed equivalent lexical inferencing performance to that of their native speaking peers. Similar findings were reported recently by Luk and her colleagues (2015) in a study comparing reading comprehension performance in native speaking and language minority 4th grade students. In that study, language minority but not native speaking children recruited executive functions to achieve reading comprehension. These findings enhance the notion that language minority students can compensate for their lower vocabulary by recruiting cognitive resources to support lexical inferencing, and to achieve equivalent performance to that of their native speaking peers.

Finally, reading comprehension contributed significantly to lexical inferencing in both language groups, above the other underlying skills. This again indicates that better overall reading comprehension performance contributes to better ability to infer the meaning of an unknown word during reading, as shown previously for L1

(Cain et al., 2003; Ricketts et al., 2011; Swanborn & De Glopper, 2002) and L2 (Prior et al., 2014; Pulido, 2007) readers. This finding, that good readers (both in terms of decoding and in terms of comprehension) learn more word meanings incidentally than poor readers, implies that the gap between good and poor readers may only grow wider over time and experience (Stanovich, 1986; Swanborn & De Glopper, 2002). This point may be especially relevant for language minority students, who demonstrate reduced vocabulary and reading comprehension abilities throughout elementary and secondary education, even after immersion in the societal language for several years (Geva & Wiener, 2015).

Possible risk for lexical inferencing difficulties in language minority students

In the current study, a number of students from both language groups were unable to complete the lexical inferencing task. These students had lower performance in literacy and language measures compared to their respective group. However, this subgroup was larger among the language minority children (14% of the language minority students and 5% of the native speaking students out of the initial sample), demonstrating the vulnerability of the language minority group.

Thus, the finding of equal lexical inferencing performance at the group level must be somewhat qualified in light of the larger percent of language minority children who were unable to perform the task. Further, when considering the more linguistically complex texts used in upper elementary grades, language minority children might be at a higher risk of failing to successfully infer the meanings of unknown words from context.

Future research

The texts used in the current study were specifically designed to experimentally test lexical inferencing abilities. Further, all target items in the current study were concrete nouns, and did not include rich part-of-speech and morphological markings, which children could use as a source of information for successful lexical inferencing (Kieffer & Lesaux, 2007). Future research could therefore extend and test the generalizability of the current findings by using more authentic texts, taken from regular classroom study materials, and a greater variety of target items. Finally, in the current study we did not directly measure children's knowledge of all words appearing in the texts, and thus do not have a measure of text coverage, an issue that can be investigated in future research.

Implications

We propose that lexical inferencing can serve as a tool for enhancing reading comprehension and vocabulary growth for language minority children, as has been previously demonstrated for native speaking children (Cain et al., 2003; Ricketts et al., 2011; Swanborn & De Glopper, 2002) and adults learning an L2 (Elgort et al., 2015; Nassaji, 2006). The current results suggest several important pedagogical implications that should be tested directly in future research.

The first and most important recommendation is that texts presented to language minority students with the goal of supporting incidental vocabulary learning, inter alia, need to be designed to meet these students' existing levels of vocabulary. Thus, in the relatively easy texts used in the current study, language minority students demonstrated good lexical inferencing abilities. However, it is possible that language minority students might not be able to benefit from lexical inferencing in more complex texts, which exceed their threshold vocabulary knowledge. Providing language minority students with texts that are well-matched to their vocabulary provides them with opportunities to successfully infer the meaning of unknown words and thus enhance their reading comprehension and promote their vocabulary growth.

Second, we suggest that it is important to raise the learners' awareness to the power of incidental word learning, especially among language minority learners. Because there is evidence that readers tend to ignore many unknown words (Haastrup, 1991; Paribakht & Wesche, 1999), teachers should explicitly encourage students to pay attention to unfamiliar words while reading. Further, as suggested by others, teachers might explicitly present students, and specifically language minority students, with strategies for contextual word learning (e.g., Kame'enui & Baumann, 2012; Pressley, Disney, & Anderson, 2007) and support students in implementing such strategies while reading independently.

Conclusion

In the current study, upper elementary language minority students had similar lexical inferencing abilities to their native speaking peers, despite having lower vocabulary knowledge, and marginally lower reading comprehension abilities. Importantly, lexical inferencing ability was measured in texts using simple every-day language, such that language minority learners might have achieved the threshold vocabulary necessary for this task. In addition, the language minority students recruited non-verbal inferencing to support lexical inferencing, in contrast to the native speaking children, which might have allowed them to compensate for any remaining vocabulary gaps. These findings suggest that lexical inferencing can serve as an efficient tool for supporting reading comprehension and vocabulary development in language minority learners. However, we also

identified increased vulnerability of language minority learners in the domain of lexical inferencing, and suggest several pedagogical avenues for further supporting this population.

Appendix 1

Performance of the omitted participants in comparison to retained participants of their respective group

	Native Hebrew		Language minority	
	Omitted N = 3	Retained N = 53	Omitted N = 8	Retained N = 48
Vocabulary	37	41	31	35
Reading accuracy	83%	88%	82%	86%
Reading comprehension	14	24	17	22
Non-verbal ability	12	26	23	23

Appendix 2: Lexical Inferencing Task: Sample Story

Everyone says that 13-year-old Alon is a "born actor." His parents say that even when he was 2 years old, he would stand at the table at family events and entertain the audience. When a theater department was opened at the performing arts school, it was clear that Alon would be the first to sign up for it. The theater class puts on shows twice a year. In preparation for the show, many rehearsals are held in the afternoons as well, and students spend a lot of time working on the sets and the characters' costumes. For the first role he played, Alon had to find a *shoftar*. Alon asked friends and neighbors if any of them had a *shoftar* and explained that he needed it because he was playing the role of an old man who has trouble keeping stable while walking. When he did not find what he was looking for, Alon had an idea—he went to the retirement home near his house and asked if they could help him out. The retirement home staff was happy to help him and promised to come see the play.

Appendix 3

Number of participants receiving each score (0, 1, 2), by text and by language group

	Native Hebrew N = 53			Language minority N = 48		
	0	1	2	0	1	2
Text 1	28	0	25	18	2	28
Text 2	13	19	21	14	16	18
Text 3	6	14	33	12	13	23
Text 4	19	2	32	15	7	26
Text 5	10	3	40	10	1	37
Text 6	15	3	35	15	3	30
Text 7	23	15	15	22	16	10
Text 8	17	6	30	17	8	23

Appendix 4

Correlations among lexical inferencing and other experimental tasks, by language group

	Native Hebrew speakers N = 53				Language minority N = 48			
	2	3	4	5	2	3	4	5
1. Vocabulary	.23	.33*	.25	.32*	.19	.05	.51**	.34*
2. Word reading accuracy		.07	.39**	.53**		.25	.37*	.36*
3. Non-verbal ability			.19	.26			.23	.36*
4. Reading comprehension				.56**				.52**
5. Lexical inferencing								

$*p < .05$; $**p < .005$; $***p < .001$

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