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Morpho-lexical development in language impaired and typically developing Hebrew-speaking children from two SES backgrounds

Ronit Levie[1] · **Galit Ben-Zvi**[2] · **Dorit Ravid**[3]

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Abstract The study investigated the impact of language impairment and environmental deprivation on Hebrew morpho-lexical development across the school years. Participants were 659 grade school and middle school Hebrew-speaking students—typically developing and language impaired, from mid-high and from low socio-economic status (SES). They were all administered three derivational morphology tasks designed to elicit verbs, adjectives and derived abstract nouns. Each response was scored in three different ways: as a whole word, and according to its base (root or stem) and affixal (pattern or suffix) morphemes. Findings revealed three systematic hierarchies. First, the typically developing mid-high SES group always scored the highest, the language impaired low SES group always scored the lowest, while the typically developing low SES and the language impaired mid-high SES groups lay in-between. Second, verbs were the easiest category across all study groups, whilst adjectives and derived abstract nouns proved to be more affected by population type. Third, affixal morpheme always scored lower than base morpheme, with persistent gaps between the typically developing mid-high SES group and all other groups. Altogether, results show that language development is impeded extensively by both language impairment and SES factors, suggesting that in the long run, innate and environmental factors may have similar implications on morpho-lexical development.

Morpho-lexical Development in Language Impaired and Typically Developing Hebrew-speaking Children from two SES Backgrounds.

✉ Ronit Levie
levieron@gmail.com

[1] Department of Communication Disorders, Faculty of Medicine, Tel Aviv University, Ramat Aviv, Tel Aviv 699978, Israel

[2] Ono Academic College, Kiryat Ono, Israel

[3] Tel Aviv University, Tel Aviv, Israel

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Introduction

Failing to acquire a literate, extensive vocabulary has significant consequences regarding higher-order cognitive and linguistic abilities and subsequent academic attainments (Nation, Snowling, & Clarke, 2007; Verhoeven & Perfetti, 2011). Both children with language impairment and those growing up in low SES environments experience substantial problems in processing linguistic information, most significantly in establishing relationships among words and learning new vocabulary (Lawrence, Capotosto, Branum-Martin, While, & Snow, 2012; Marshall & Van Der Lely, 2007). The current study compares the effects of low SES and language impairment on morpho-lexical development in Hebrew. To this end, we tested typically developing and language impaired Hebrew speaking gradeschool and middle school students from mid-high compared with low SES backgrounds. This period of middle childhood to adolescence is considered critical in developing the language of literacy (Llauradó & Tolchinsky, 2013) and establishing school-based vocabulary and the morphological categories that organize it (Berman, 2007). We expected performance to be affected not only by grade level, lexical category and morphological structure, but also by language impairment, SES background, and most especially by their combination.

Morpho-lexical development in language impaired and low socio-economic status children

Children with language impairment (LI) have primary difficulties in processing phonological, lexical and morpho-syntactic information, manifested in a later onset and a slower pace of language development (Leonard, 2014). Once at school, these children demonstrate difficulties in gaining command of linguistic literacy, reading accuracy and comprehension, spelling, and text writing (Brizzolara et al., 2011; Goulandris, Snowling, & Walker, 2000; Whitehouse, Line, Watt, & Bishop, 2009). Children with LI struggle in gaining lexical learning, with lower estimates of vocabulary size, diversity and quality (Kornilov, Magnuson, Rakhlin, Landi, & Grigorenko, 2015; Mainela-Arnold, Evans, & Coady, 2008; McGregor, Oleson, Bahnsen, & Duff, 2013). They moreover find it difficult to process morphological information and establish structural and semantic relationships among words (Swisher & Snow, 1994; Wolter & Green, 2013), resulting in reading and writing deficiencies (Moats & Smith, 1992).

Low SES is known to affect child development in every possible sense (Hackman & Farah, 2009; Yoshikawa, Aber, & Beardslee, 2012), especially impeding linguistic development (Ginsborg, 2006; Noble, Norman, & Farah, 2005). Children from poorer, less educated backgrounds do not reach the same language and literacy gains as children raised in more favourable circumstances (Kieffer, 2012; Manz, Hughes,

Barnabas, Bracaliello, & Ginsburg-Block, 2010; Sparks & Reese, 2013). Research indicates that from infancy, lexical repertoire lags in low SES behind that of more advantaged peers (Black, Peppe, & Gibbon, 2008; Fernald, Marchman, & Weisleder, 2013; Rowe, Raudenbush, & Goldin-Meadow, 2012), showing slower trajectories of oral and written vocabularies growth (Farkas & Beron, 2004; Hoff, 2013; Walker, Greenwood, Hart, & Carta, 1994). Consequently, low SES children may experience academic failure from early on, and their literacy attainments remain consistently lower than average across the school years (Purcell-Gates & Dahl, 1991; Sirin, 2005).

Although both populations have been widely investigated, few studies have compared the impact of environmental deprivation and language disorders. One such study showed that typically developing fourth and eighth grade Hebrew-speaking children from high SES scored the highest on proverb comprehension, followed by typically developing peers from low SES and finally by children with LI from high SES background (Berman & Ravid, 2010). The same hierarchy was obtained among the three populations on derivational morphology tasks (Berman, Nippold, & Ravid, 2007).

Morphological aspects of lexical development

Learning the content word lexicon of nouns, verbs, and adjectives is a graded process (Gaskell & Ellis, 2009; Landauer, Kireyev, & Panaccione, 2011; Nippold, 2002), requiring frequent encounters with words in diverse contexts (Davis & Gaskell, 2009; Landauer & Dumais, 1997). It requires command of *lexical quality* (Perfetti, 2007), represented by a network of orthographic, phonological, morpho-syntactic, and semantic representations of the word (Schmitt, 2014; Snow, 2010; Sun & Nippold, 2012). Knowledge of derivational morphology has been shown to deeply contribute to vocabulary learning (Deacon, Whalen, & Kirby, 2011; Nagy, Carlisle, & Goodwin, 2014; Rabin & Deacon, 2008).

Throughout the school years, derivational morphology becomes increasingly more complex, encoding semantically more abstract and specific concepts (Bertram, Hyönä, & Laine, 2011; Larsen & Nippold, 2007; Marinellie & Kneile, 2012). According to Anglin (1993), at least half of the words in an English speaking child's lexicon are acquired through morphological processes of form-to-meaning mapping. Thus, it is imperative in developing the school-based, academic vocabulary (Carlisle, 2010; Jarmulowicz & Taran, 2013; Lesaux, Kieffer, Faller, & Kelley, 2010). For children growing up in Hebrew, a highly synthetic Semitic language where most spoken and written words are related through their morphemes, derivational knowledge is critical (Berman, 2007; Ravid, 2003).

Hebrew derivational morphology and the content word lexicon

Hebrew words combine core lexical information with categorical classification in two major morphological processes (Bolozky, 1999; Ravid, 2012). One is the nonlinear affixation of root and pattern, for example, *zahir* "cautious" based on the

combination of root *z–h–r* and adjectival pattern *CaCiC*.[1] Root and pattern affixation yields the basic Hebrew word, creating morphological families based on roots—for example, root *z–h–r* in *nizhar* "be cautious", *hizhir* "warn", *azhara* "warning", and *zahir* "cautious"; or on patterns, such as the adjectival pattern *CaCiC* shared by *zahir* "cautious", *bahir* "light", *xaviv* "kind", and *mahir* "fast". A second morphological process is the linear suffixation of words, as in *zehirut* "caution", where abstract suffix *-ut* attaches to adjective *zahir* "cautious" (Ravid, 2006b).

This morphological organization makes Hebrew lexical learning dependent on extracting structural and semantic connections between words. Hebrew acquiring children learn to use morphological structures as pointers to word category and possible meanings as early as in their third year of life (Berman, 1985; Ravid et al., 2016a). This ability drives new word learning from preschool and on to the school years and beyond, especially when lexical learning interfaces with the acquisition of written literacy (Ravid, 2004; Ravid & Schiff, 2006b). By adolescence, Hebrew speakers/writers reach productive command of both nonlinear and linear morphology, effectively handling the structural opacity and semantic complexity, characterizing the high register academic Hebrew vocabulary (Ben-Zvi & Levie, 2016).

Hebrew-speaking children with LIs are not as effective in manipulating roots and patterns, in generalizing morphological knowledge to unfamiliar words, and in forming links between words (Ravid, Ben-Zvi, & Levie, 1999; Ravid, Levie, & Ben-Zvi, 2002, 2003; Schiff, Cohen, Ben-Artzi, Sasson, & Ravid, 2016; Schiff & Ravid, 2007). Likewise, Hebrew speakers from low SES find derivation challenging, showing reduced sensitivity to word structure and a lesser ability to analyze written words into their morphemes (Ravid & Schiff, 2006a; Schiff & Lotem, 2011).

Against this background, the current study investigated derivational and lexical skills in typically developing and language impaired Hebrew-speaking children from mid-high and low SES. The three target categories selected for investigation during the school years were (1) verbs, with Hebrew-typical root and pattern structure, whose acquisition starts early, yet is drawn out to adolescence to accommodate complex temporal expression (Ben-Zvi & Levie, 2016; Berman, 1993); (2) adjectives, a small lexical class with variegated morphological structures that has proved diagnostic across age groups and different populations (Polinsky, 2004; Ravid & Levie, 2010); and (3) morphologically derived abstract nouns, a key category in later cognitive and morpho-lexical development (Nagy & Townsend, 2012; Ravid, 2006a). Developmentally, we expected success to improve with grade level in all study groups. With regard to lexical categories, we predicted verbs to be the easiest, with adjectives and abstract nouns posing a greater challenge for all groups. We also expected success in all categories to benefit from word familiarity (Carlisle & Katz, 2006; Colombo, Pasini, & Balota, 2006). With regard to morphological structures, we expected the base morpheme (root or word stem) to score higher than the affixal morpheme—pattern or suffix (Deutsch, Frost, & Forster, 1998; Schiff & Ravid, 2007). Finally, in terms of study groups, we expected language impairment, as an innate disorder, to have a greater detrimental impact on

[1] Capital C's are used to indicate the places where root radicals are inserted into the pattern.

morpho-lexical learning than SES background (Berman & Ravid, 2010). We also expected language impaired children from low SES to make the lowest morpho-lexical gains in the study (Craig & Washington, 2000; Engel de Abreu, Cruz-Santos, & Puglisi, 2014; Fazio, 1999).

Methodology

Study groups

The study population consisted of 659 children and adolescents aged 6–14, all monolingual native speakers of Hebrew, attending age-appropriate grade schools and middle schools in the Tel Aviv area. Four schooling levels participated in the study, each composed of two adjacent grade levels: 177 first to second graders, 196 third to fourth graders, 179 fifth to sixth graders, and 107 seventh to eighth graders. Each schooling level consisted of four study groups: (1) typically developing mid-high SES participants (henceforth TDH); (2) typically developing low SES participants (TDL); (3) language impaired mid-high SES participants (LIH); and (4) language impaired low SES participants (LIL). The full array of the four study groups is presented in Table 1.

All participants had normal hearing and sight (or sight corrected by spectacles). The typically developing participants had no recorded developmental, neurological (including ADD and ADHD), language or learning disorders, with school records indicating at least average academic achievements. All language impaired (LI) participants had been diagnosed by language disability specialists in the school services, with no other developmental, neurological (including ADD/ADHD), or emotional problems. Dyslexic children and those with records of attending special education were excluded from the study. Regarding SES, participants were recruited according to the Ministry of Education SES Index (Zuzovsky & Olshtain, 2008) which ranks schools on a scale of 1–10, based on aggregated information for the attending students: mean number of years of parental schooling, percentage of parents who work as professionals, average monthly per capita income of family,

Table 1 Study groups by grade levels

Grade levels	Study groups				Total
	TDH	*TDL*	*LIH*	*LIL*	
G1 + G2	63	60	28	26	177
G3 + G4	63	61	48	24	196
G5 + G6	63	69	32	15	179
G7 + G8	31	36	23	17	107
Total	220	226	131	82	659

G Grade level, *TDH* typically developing mid-high SES, *TDL* typically developing low SES, *LIH* language impaired mid-high SES, *LIL* language impaired low SES

family size, mean housing density, peripheral vs. central location, and neighborhood statistical information. The high SES schools were located in a wealthy neighborhood, ranked as 1.56 (gradeschool) and 1.21 (middle school)—that is, within the highest SES range; whereas the low SES schools were located in a disadvantaged area, and ranked as 7.62 (gradeschool) and 7.93 (middle school), within the lowest SES range, thus entitled to a special budget allotment on Ministry of Education SES Index.

Materials

The morpho-lexical test consisted of three derivational tasks with 31 items altogether, each task targeting a different category in the literate lexicon—verbs, adjectives, and derived abstract nouns. The task length was in keeping with the requirements of the Ministry of Education and school authorities so as to be administered during a single study period even in the weaker study groups. All task items (target responses), including their source words, morphological structures and familiarity ratings (see below), are presented in Table 2.

The verb task consisted of 15 items, representing the six derived *binyan* verb patterns (excluding basic *Qal*) expressing five syntactico-semantic functions (Berman, 1993): causativity (e.g., *higdil* "enlarge"), inchoativity (e.g., *hexvir* "become pale"), reflexivity (e.g., *hitlabeš* "get dressed"), reciprocity (e.g., *hitkatev* "correspond"), and passive voice (e.g., *huxzar* "be returned"). The adjective task consisted of 10 items, representing four morphological adjective classes (Ravid & Nir, 2000): resultative (e.g., *menusar* "sawn") and potential adjectives (*šavir* "breakable"), with root and pattern structure; diminutive adjectives (*ktantan* "tiny"), with reduplicative structure;[2] and denominal adjectives (*harari* "mountainous"), derived from nouns, with linear structure. The derived abstract noun task contained six irregular nouns in two semantic subsets: action nouns such as *da'ig* "fishing" and emotive nouns such as *buša* "shame" (Ravid & Avidor, 1998).

Familiarity ratings

As Hebrew does not currently have reliable normalized frequency values for words[3], a familiarity questionnaire was constructed to determine the effect of word familiarity on participants' correct scores (Kuperman & Van Dyke, 2013). We asked 52 adults in expert educational roles to rate the familiarity of each of the 31 test items on a randomized list. The instructions were as follows: "Please rate each of the words in the list below on a scale of 1–4 (where 1 = Non-familiar, 4 = Very familiar) two times, according to your idea of how familiar it is to (1) gradeschool students (have a fourth grader in mind); (2) middle school students."

[2] Similar though not identical to root and pattern structure (Hora, Avivi Ben-Zvi, Levie, & Ravid, 2007).

[3] Frequency norms available in Hebrew rely on daily newspapers, hence not appropriate for developmental purposes. Furthermore, they do not take into account the homography phenomenon which is typical to the Hebrew written system. However, studies have shown a strong relation between subjective judgments and objective frequency estimates from corpora (see for example—Balota, Pilotti, & Cortese, 2001).

Table 2 Breakdown of the three morpho-lexical tasks, by category and morpho-semantic sub-categories, source words, test items, morphological structure and familiarity rating of test items

Category (task)	Morpho-semantic sub-category	Source words	Test items (target responses)	Morphological structure of test items	Familiarity rates of test items	
					*G*1–*G*6	*G*7–*G*8
Verbs (in past tense)	Causativity	*gadol* (Adj) "big"	*higdil* "enlarge"	root and pattern	3.16	3.76
		kacar (Adj) "short"	*kicer* "shorten"	root and pattern	2.96	3.8
		axal (V) "eat"	*he'exil* "feed"	root and pattern	3.68	3.96
	Inchoativity	*xiver* (Adj) "pale"	*hexvir* "become pale"	root and pattern	1.8	3.0
		bašel (Adj) "ripe"	*hivšil* "ripen"	root and pattern	2.12	3.12
		satum (Adj) "blocked"	*nistam* "become blocked"	root and pattern	3.0	3.88
	Reflexivity	*hilbiš* (V) "dress"	*hitlabeš* "get dressed"	root and pattern	3.96	4.0
		gile'ax (V) "shave"	*hitgale'ax* "shave oneself"	root and pattern	3.68	3.96
		nika (V) "clean"	*hitnaka* "clean oneself"	root and pattern	2.76	3.6
	Reciprocity	*katav* (V) "write"	*hitkatev* "correspond"	root and pattern	3.08	3.8
		nišek (V) "kiss"	*hitnašek* "kiss each other"	root and pattern	3.88	4.0
		laxaš (V) "whisper"	*hitlaxeš* "whisper to each other"	root and pattern	3.16	3.92
	Passive voice	*hexzir* (V) "return"	*huxzar* "be returned"	root and pattern	2.2	3.4
		siper (V) "tell"	*supar* "be told"	root and pattern	2.12	3.32
		šalax (V) "send"	*nišlax* "be sent"	root and pattern	3.28	3.88
				Mean familiarity rates of verbs		
					2.99 (.68)	3.69 (.33)

Table 2 continued

Category (task)	Morpho-semantic sub-category	Source words	Test items (target responses)	Morphological structure of test items	Familiarity rates of test items	
					*G*1–*G*6	*G*7–*G*8
Adjectives	Resultative	*niser* (V) "saw"	*menusar* "sawn"	root and pattern	2.04	2.92
		histir (V) "hide"	*mustar* "hidden"	root and pattern	2.72	3.6
		bana (V) "build"	*banuy* "built"	root and pattern	3.0	3.8
	Potential	*šavar* (V) "break"	*šavir* "breakable"	root and pattern	3.08	3.8
		raxac (V) "wash"	*raxic* "washable"	root and pattern	1.56	2.56
	Reduplicative Diminutive	*katan* (Adj) "small"	*ktantan* "tiny"	root and pattern	3.26	3.88
		varod (Adj) "pink"	*vradrad* "pinkish"	root and pattern	2.64	3.76
	Denominal	*harim* (N) "mountains"	*harari* "mountainous"	stem and suffix	1.56	2.72
		kesef (N) "money"	*kaspi* "financial"	stem and suffix	1.84	3.24
		dov (N) "bear"	*dubi* "bear-like"	stem and suffix	1.36	2.16
				Mean familiarity rates of adjectives		
					2.31 (.71)	3.24 (.62)
Derived abstract nouns	Action nominals	*dag* (V) "fish"	*da'ig* "fishing"	root and pattern	2.87	3.55
		xozer (V) "repeat"	*xazara* "repetition"	root and pattern	3.55	3.97
		mekalel (V) "curse"	*klala* "curse"	root and pattern	3.68	3.89
	Emotive nominals	*mitbayeš* (V) "is ashamed"	*buša* "shame"	root and pattern	3.11	3.87
		mitxaret (V) "regret"	*xarata* "regret, remorse"	root and pattern	2.45	3.29

Table 2 continued

Category (task)	Morpho-semantic sub-category	Source words	Test items (target responses)	Morphological structure of test items	Familiarity rates of test items	
					*G*1–*G*6	*G*7–*G*8
		nid'ham (V) "is amazed"	*tadhema* "amazement"	root and pattern	1.82	2.71
				Mean familiarity rates of derived abstract nouns		
					2.91 (.70)	3.55 (.48)

For every specific test item Table 2 reports the lexical category and sub-category, the source word from which it derives (*V* verb, *N* noun, *Adj* adjective), the morphological structure and the familiarity values (on a scale of 1–4, where 1 = Non-familiar, 4 = Very familiar) for the two schooling levels (grade-school = G1–G6, middle school = G7–G8). The table also reports mean familiarity values for each category

Procedure

Testing took place in a quiet room at school during the second half of the school year. Participants were tested orally and individually by the three authors, trained psycholinguists and speech-language pathologists. The shorter derived abstract nouns task was always presented first, followed by either the adjective or the verb tasks in balanced order. Within each task, test items' order was determined randomly, and sentences were presented to participants in a fixed order. Each task was preceded by three training items, but instructions did not include linguistic terms such as *root* or *noun*. For each category, participants were presented with a set of sentences to be completed by one word. Correct completion required the derivation of a content word (the target response—verb, adjective or derived abstract noun) from a source word (verb, noun or adjective) in each sentence. Whilst all test items belong to the advanced Hebrew lexicon, source words are part of the core Hebrew lexicon.[4] For example, the sentence "The feeling a person has when s/he *nidham* "is amazed" [=source word] is…" had to be completed by the derived abstract noun *tadhema* "amazement", based on the same root *d–h–m*. Length of assessment varied between 20 and 40 min, depending on age and ability of participants.

Scoring and analyses

A database of 20,429 responses (659 participants × 31 items) was constructed. Three separate analyses were carried out on these responses, each focusing on a

[4] 24 experts were asked to rate the familiarity of each of the source words, on a scale identical to the one reported for the test items (a scale of 1–4 where 1 = Non-familiar, 4 = Very familiar) and for the same two schooling levels (gradeschool and middle school). Mean familiarity values for the source words were 3.62 (SD = .36) for gradeschool, and 3.89 (SD = .2) for middle school.

different facet of Hebrew content word composition: The lexical analysis assessed the derived word as a whole, serving as the general success score on the task. Two additional, morphological analyses were carried out to assess (1) the base morpheme (root or stem) of the required word, and (2) its affixal morpheme (pattern or suffix). To illustrate this scoring procedure, consider the causative verb *kitser* "shortened", derived from root *q–c–r* "short" and verb pattern *Pi'el*. The wholistic lexical analysis assigned a correct score only to the target verb *kitser*. The base morpheme analysis assigned a correct score to the target root *q–c–r* regardless of affix correctness, as in *hitkatser* "become short". The affix morpheme analysis assigned a correct score to verbs in the target *binyan* pattern *Pi'el* regardless of root correctness, for example, *kipel* "folded". The scoring method yielded a further database of 61,287 scored components (20,429 responses × 3 scores). This detailed procedure made it possible to assess not only the accuracy of each response (correct scores on the three different analyses), but also to conduct an error analysis. In the current paper we focus on correct scores.

To conduct a comparative analysis we calculated the average correct score across the three analyses (base, affixal, and lexical scores) and conducted a GLM model, in which these three score types are repeatedly measured (assuming dependency across score types). Using the repeated measure GLM mitigated some of the unweighing sub-sample sizes. Grade level and study group were two independent factors. The three analyses were performed separately for verbs, adjectives, and derived abstract nouns.

Results

Tables 3, 4 and 5 present mean scores by grade level (4: G1 + G2, G3 + G4, G5 + G6, G7 + G8), study groups (4: TDH, TDL, LIH, LIL) and score types (3: lexical, base morpheme, affixal morpheme) for each content word category (3: verbs, adjectives, derived abstract nouns).

Verbs

A three-way GLM (4 grade levels × 4 study groups × 3 score types) on Table 3 showed all main effects: grade level, $F(3,643) = 201.87$, $p < .001$, study group $F(3,643) = 94.49$, $p < .001$, and score type, $F(2,1286) = 1934.2$, $p < .001$. The following two-way interactions emerged: grade level × study group, $F(9,643) = 2.06$, $p < .001$, grade level × score type, $F(6,1286) = 10.22$, $p < .001$, and study group × score type, $F(6,1286) = 12.62$, $p < .001$. They were all included within the three-way interaction, $F(18,1286) = 2.56$, $p < .001$, of grade level × study group × score type in Fig. 1.

Figure 1 and Bonferroni post hoc analyses showed that across the four study groups and all grade levels, the base score was always significantly higher than the affix and lexical scores. Regarding the base score, younger groups showed significant differences among the four study groups (TDH > TDL > LIH > LIL), with gaps closing among all but the LIL by G7 + G8. A rather similar pattern

Table 3 Verbs

Score types	TDH				LIH			
	*G*1 + *G*2	*G*3 + *G*4	*G*5 + *G*6	*G*7 + *G*8	*G*1 + *G*2	*G*3 + *G*4	*G*5 + *G*6	*G*7 + *G*8
Lexical score	40.06	66.48	78.63	82.54	19.85	38.26	50.09	71.59
	(18.59)	(14.72)	(12.36)	(9.42)	(14.78)	(17.67)	(20.04)	(10.42)
Base score	68.68	90.36	96.65	95.74	48.61	69.61	77.72	91.96
	(22.3)	(10.79)	(5.91)	(6.93)	(18.44)	(19.53)	(18.95)	(7.95)
Affixal score	44.68	67.42	79.57	83.61	25.75	42.94	53.59	73.31
	(18.19)	(14.41)	(11.41)	(9.31)	(14.33)	(17.08)	(20.08)	(9.84)
Score types	TDL				LIL			
	*G*1 + *G*2	*G*3 + *G*4	*G*5 + *G*6	*G*7 + *G*8	*G*1 + *G*2	*G*3 + *G*4	*G*5 + *G*6	*G*7 + *G*8
Lexical score	27.4	46.01	62.12	71.95	13.44	27.4	41.04	60.01
	(15.98)	(18.21)	(14.57)	(13.97)	(12.43)	(13.05)	(16.06)	(17.84)
Base score	58.09	79.55	88.71	95.05	35.52	55.17	70.52	83.69
	(21.93)	(18.06)	(12.81)	(6.19)	(17.74)	(20.59)	(17.61)	(15.14)
Affixal score	32.35	49.25	63.56	73.05	19.02	32.9	43.24	62.34
	(15.45)	(16.54)	(13.66)	(13.79)	(11.74)	(11.94)	(15.74)	16.13))

Percentage means and standard deviation (in brackets) of correct production of the full word (lexical score), on the root or stem (base score), and on the pattern or suffix (affixal score), by study group

G Grade level, *TDH* typically developing mid-high SES, *TDL* typically developing low SES, *LIH* language impaired mid-high SES, *LIL* language impaired low SES; The maximum score in all analysis is 100

Table 4 Adjectives

Score types	TDH				LIH			
	*G*1 + *G*2	*G*3 + *G*4	*G*5 + *G*6	*G*7 + *G*8	*G*1 + *G*2	*G*3 + *G*4	*G*5 + *G*6	*G*7 + *G*8
Lexical score	26.14	53.01	69.98	70.87	11.25	23.07	33.79	48.32
	(18.55)	(22.35)	(18.22)	(15.96)	(10.6)	(14.9)	(21.69)	(12.77)
Base score	41.07	68.1	78.47	79.88	26.81	45.34	54.83	69.87
	(18.94)	(18.69)	(14.61)	(11.85)	(13.83)	(20.52)	(21.03)	(12.12)
Affixal score	31.64	58.67	73.13	73.75	17.97	30.49	42.15	55.64
	(19.78)	(22.74)	(17.55)	(14.5)	(13.43)	(18.21)	(21.05)	(14.54)
Score types	TDL				LIL			
	*G*1 + *G*2	*G*3 + *G*4	*G*5 + *G*6	*G*7 + *G*8	*G*1 + *G*2	*G*3 + *G*4	*G*5 + *G*6	*G*7 + *G*8
Lexical score	13.04	28.43	40.31	51.05	5.95	13.79	18.16	32.45
	(14.25)	(19.5)	(22.65)	(19.07)	(9.39)	(16.38)	(12.67)	(18.92)
Base score	28.39	50.82	62.84	72.77	18.9	35.65	43.9	54.58
	(20.16)	(19.63)	(20.61)	(13.25)	(16.09)	(24.42)	(17.42)	(18.21)
Affixal score	18.16	34.92	46.48	55.17	11.28	19.56	23.44	40.6
	(17.37)	(21.57)	(22.54)	(17.94)	(11.38)	(16.59)	(16.08)	(19.49)

Percentage means and standard deviation (in brackets) of correct production of the full word (lexical score), on the root or stem (base score), and on the pattern or suffix (affixal score), by study group

G Grade level, *TDH* typically developing mid-high SES, *TDL* typically developing low SES, *LIH* language impaired mid-high SES, *LIL* language impaired low SES; The maximum score in all analysis is 100

Table 5 Derived abstract nouns

Score types	TDH				LIH			
	*G*1 + *G*2	*G*3 + *G*4	*G*5 + *G*6	*G*7 + *G*8	*G*1 + *G*2	*G*3 + *G*4	*G*5 + *G*6	*G*7 + *G*8
Lexical score	9.9	26.93	40.02	48.37	4.53	12.0	17.5	31.85
	(16.72)	(24.74)	(24.85)	(27.52)	(6.89)	(12.89)	(17.78)	(17.45)
Base score	71.19	83.76	91.09	91.48	67.59	80.75	85.05	86.37
	(24.96)	(16.63)	(11.02)	(14.05)	(22.67)	(17.47)	(15.88)	(15.46)
Affixal score	9.9	26.93	40.02	48.9	6.3	12.0	17.5	34.0
	(16.72)	(24.74)	(24.85)	(27.52)	(11.05)	(12.89)	(17.78)	(18.61)
Score types	TDL				LIL			
	*G*1 + *G*2	*G*3 + *G*4	*G*5 + *G*6	*G*7 + *G*8	*G*1 + *G*2	*G*3 + *G*4	*G*5 + *G*6	*G*7 + *G*8
Lexical score	8.42	17.5	26.59	38.54	6.08	9.25	10.9	20.41
	(10.27)	(15.94)	(20.51)	(23.5)	(7.77)	(10.88)	(12.16)	(15.69)
Base score	67.27	78.63	86.85	89.05	54.94	67.69	71.4	71.85
	(22.63)	(17.65)	(16.64)	(12.16)	(24.05)	(20.91)	(21.12)	(19.14)
Affixal score	8.42	17.77	26.83	39.09	6.08	9.25	10.9	21.38
	(10.27)	(16.36)	(20.5)	(23.5)	(7.77)	(10.88)	(12.16)	(16.01)

Percentage means and standard deviation (in brackets) of correct production of the full word (lexical score), on the root or stem (base score), and on the pattern or suffix (affixal score), by study group

G Grade level, *TDH* typically developing mid-high SES, *TDL* typically developing low SES, *LIH* language impaired mid-high SES, *LIL* language impaired low SES; The maximum score in all analysis is 100

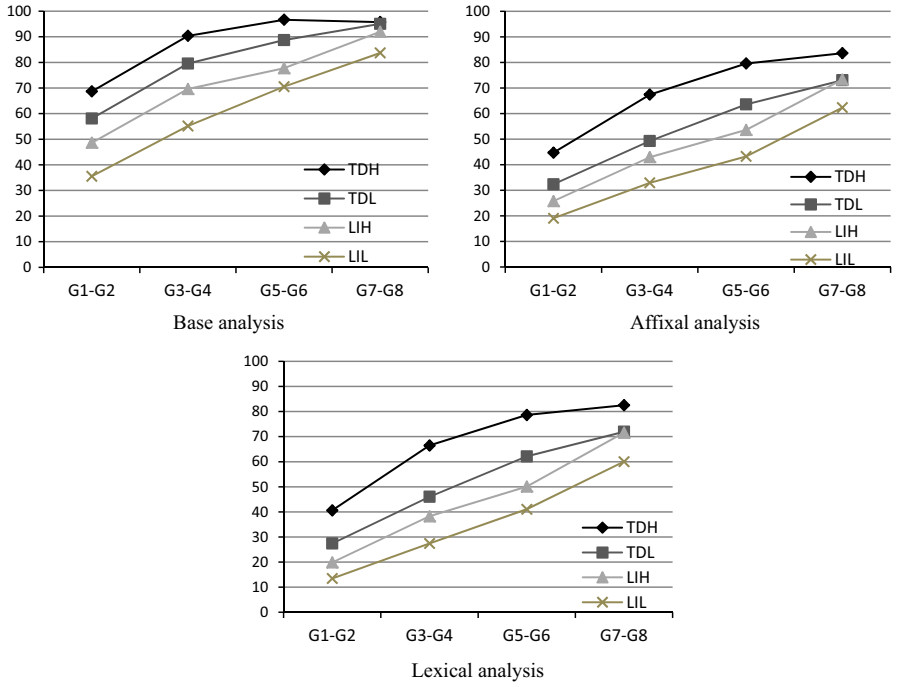

Fig. 1 Three-way interaction (grade levels, study groups, and score types) of correct responses on the verb task. *G* Grade level, *TDH* typically developing mid-high SES, *TDL* typically developing low SES, *LIH* language impaired mid-high SES, *LIL* language impaired low SES

emerged for the affix and lexical scores, however by G7 + G8 three levels were formed, with the TDL and LIH groups differing significantly from the TDH and LIL groups (TDH > TDL + LIH > LIL). For all score types, the TDH group showed significant differences among the three younger grade levels, while TDL, LIH and LIL presented significant differences among all grade levels.

Adjectives

A three-way GLM (4 grade levels × 4 study groups × 3 score types) on Table 4 showed all main effects: grade level, $F(3,643) = 112.78$, $p < .001$, study group, $F(3,643) = 91.08$, $p < .001$, and score type, $F(2,1286) = 665.42$, $p < .001$. The following two-way interactions emerged: grade level × study group, $F(9,643) = 2.67$, $p < .005$, grade level × score type, $F(6,1286) = 4.35$, $p < .001$, and study group × score type, $F(6,1286) = 13.3$, $p < .001$. They were all included within the three-way interaction of grade level × study group × score type, $F(18,1286) = 2.34$, $p < .001$, in Fig. 2.

Figure 2 and Bonferroni post hoc analyses showed that across all study groups and grade levels, the base score was once again significantly higher than affix and lexical scores. However, it was only in the TDH group that the gap between base and affix scores closed by G7 + G8. A three level hierarchy among the four study

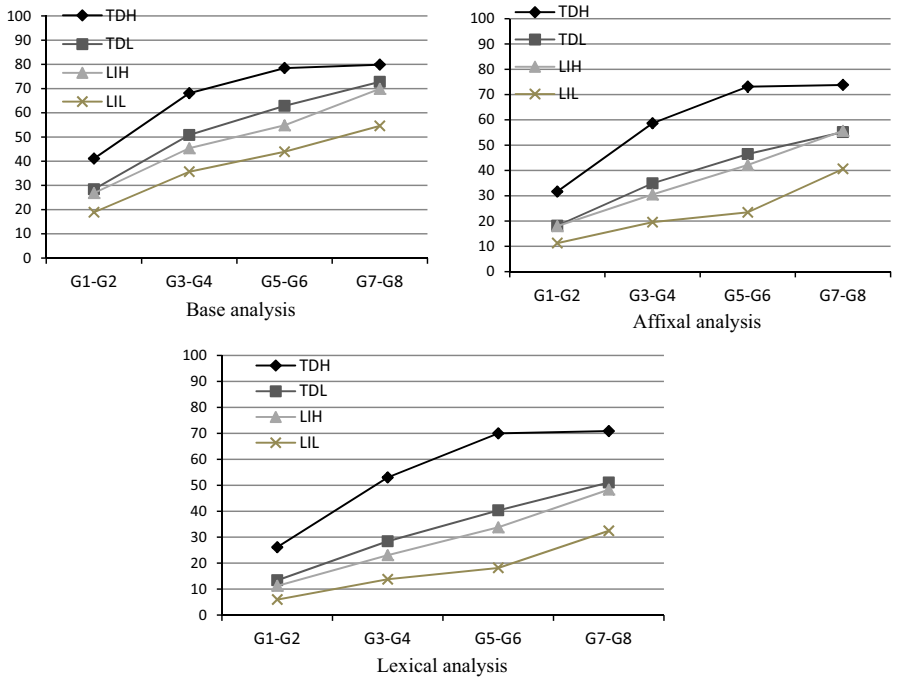

Fig. 2 Three-way interaction (grade levels, study groups, and score types) of correct responses on the adjective task. *G* Grade level, *TDH* typically developing mid-high SES, *TDL* typically developing low SES, *LIH* language impaired mid-high SES, *LIL* language impaired low SES

groups (TDH > TDL + LIH > LIL) was retained across all grade levels regarding the affix and lexical scores, and up to G5 + G6 in the base scores, with gaps closing only between TDH and TDL by G7 + G8. For all score types, the TDH group showed significant differences among the three younger grade levels, while the TDL and LIH groups presented significant differences among all grade levels. In the LIL group, the base score set apart G1 + G2 from G3 + G4, whereas the affixal and lexical scores showed significant differences only between the youngest and oldest groups.

Derived abstract nouns

A three-way GLM (4 grade levels × 4 study groups × 3 score types) on the data in Table 5 showed all main effects: grade level, $F(3,643) = 64.82$, $p < .001$, study group, $F(3,643) = 34.23$, $p < .001$, and score type, $F(2,1286) = 3159.63$, $p < .001$. The following two-way interactions emerged: grade level × study group, $F(9,643) = 2.23$, $p < .005$ (Fig. 3a), grade level × score type, $F(6,1286) = 6.02$, $p < .001$ (Fig. 3b), and study group × score type, $F(6,1286) = 4.99$, $p < .001$ (Fig. 3c).

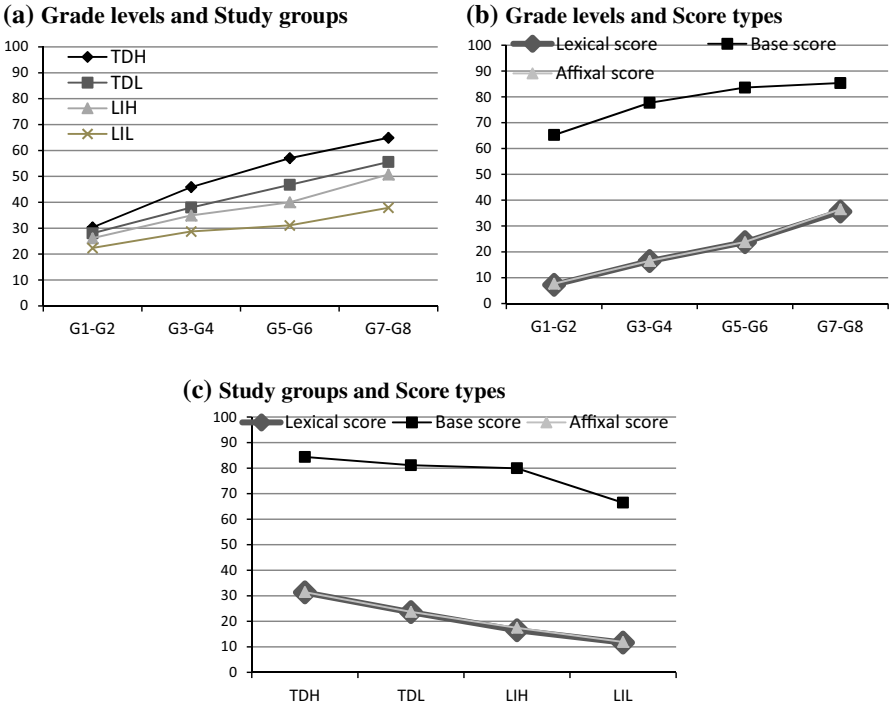

Fig. 3 **a**, **b**, **c** Two-way interactions (grade levels and study groups; grade levels and score types; study groups and score types) of correct responses on the derived abstract noun task. *G* Grade level, *TDH* typically developing mid-high SES, *TDL* typically developing low SES, *LIH* language impaired mid-high SES, *LIL* language impaired low SES

Figure 3a–c and Bonferroni post hoc analyses showed as follows: the grade level × study group interaction indicated that gaps were opening and widening among the four study groups, with a three level hierarchy in the older age groups (TDH > TDL + LIH > LIL). The TDH group showed significant differences among the three younger grade levels as well as between G3 + G4 and G7 + G8. The TDL and LIH groups presented significant differences between nonconsecutive grade levels (G1 + G2 < G5 + G6, G3 + G4 > G7 + G8). In the LIL group no significant differences were found among the four grade levels. For both grade level × score type and study group × score type, base scores were significantly higher than affix and lexical scores. The base score set apart the LIL group from the rest of the study groups, whereas a three level hierarchy TDH > TDL > LIH + LIL was found for the affix and lexical scores.

Verbs vs. Adjectives vs. Derived abstract nouns

Finally, a three-way GLM (4 grade levels × 4 study groups × 3 content word categories) was conducted on the correct lexical scores in Tables 3, 4 and 5, showing all main effects: grade level, $F(3,643) = 183.49$, $p < .001$, study group,

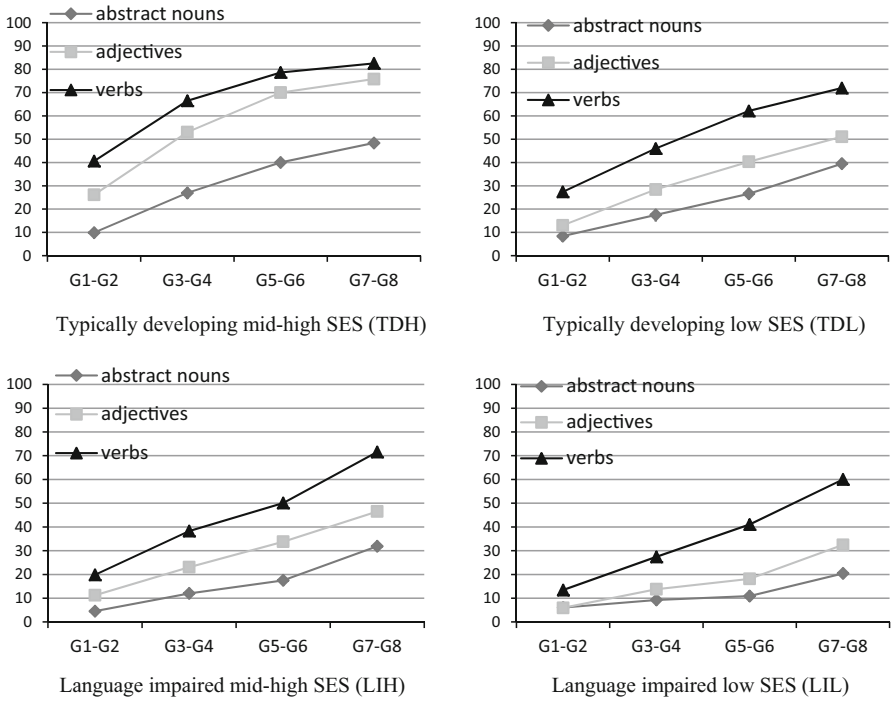

Fig. 4 Three-way interaction (grade levels, study groups and content word categories) of correct responses on the lexical analysis. *G* Grade level, *TDH* typically developing mid-high SES, *TDL* typically developing low SES, *LIH* language impaired mid-high SES, *LIL* language impaired low SES

$F(3,643) = 125.58$, $p < .001$, and content word category, $F(2,1286) = 538.37$, $p < .001$. The two-way interactions of grade level × study group, $F(9,643) = 4.02$, $p < .001$, grade level × content word category, $F(6,1286) = 10.71$, $p < .001$, and study group × content word category, $F(6,1286) = 11.55$, $p < .001$, were significant. They were all included within the three-way interaction of grade level × study group × content word category, $F(18,1286) = 1.72$, $p < .001$. Figure 4 and Bonferroni post hoc analyses showed that across the board, the same hierarchy emerged among the three categories: verbs > adjectives > derived abstract nouns, with the adjective category being the most affected category by population type. However, within this hierarchy, each study group behaved differently, as presented in Table 6.

Familiarity effects

Mean familiarity values for the 31 test items altogether rose from 2.75 ($SD = .74$) for gradeschool (G1–G6) to 3.52 ($SD = .49$) for middle school (G7–G8). Table 2 (see above) reports familiarity values for verbs, adjectives and derived abstract nouns by two schooling levels, showing that familiarity values increase for all three categories, with verbs and abstract nouns having higher familiarity scores than adjectives in both

Table 6 The significant differences ($p < .001$) between pairs of categories across schooling levels by study group

Grade levels	Study groups			
	TDH	*TDL*	*LIH*	*LIL*
G1 + G2	verbs > adjectives > abstract nouns	verbs > adjectives + abstract nouns	No differences	No differences
G3 + G4	verbs > adjectives > abstract nouns	verbs > adjectives > abstract nouns	verbs > adjectives + abstract nouns	verbs > abstract nouns*
G5 + G6	verbs + adjectives > abstract nouns	verbs > adjectives > abstract nouns	verbs > adjectives > abstract nouns	verbs > adjectives + abstract nouns
G7 + G8	verbs + adjectives > abstract nouns	verbs > adjectives + abstract nouns	verbs > adjectives > abstract nouns	verbs > adjectives + abstract nouns

G Grade level, *TDH* typically developing mid-high SES, *TDL* typically developing low SES, *LIH* language impaired mid-high SES, *LIL* language impaired low SES

* Adjectives did not differ from verbs and nouns in the LIL G3 + G4 group

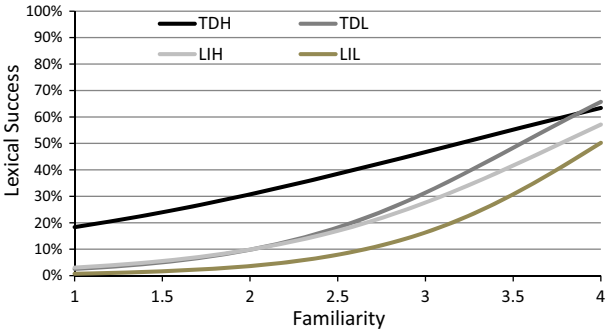

Fig. 5 Effect of change in word familiarity (1–4) on the probability to achieve correct lexical scores by study groups. *TDH* Typically developing mid-high SES, *TDL* typically developing low SES, *LIH* language impaired mid-high SES, *LIL* language impaired low SES, Familiarity rates range on a scale of 1–4 (where 1 = Non-familiar, 4 = Very familiar)

schooling levels. To analyze the effect of familiarity on the lexical score, we used the Generalized Estimating Equation (GEE) procedure,[5] which indicated that the increase in word familiarity applied to all study groups, grade levels, and content word category ($b > 0$, $p < .05$). Table 7 presents the GEE logistic regression results. Verbs gained the most from being familiar, while adjectives gained the least. Younger students (G1–G6) were more likely to benefit from familiarity with test items than older ones (G7–G8). Similarly, the TDL and LIH groups benefited more than the TDH group, while the LIL group benefited the most. The TDH group benefited most from verb familiarity and less from nouns and adjectives, while the LIL group benefited hugely from noun familiarity, followed by verbs and then adjectives. The TDL and LIH groups displayed the same pattern: verbs gain the most from familiarity, followed by nouns, with adjectives lagging behind. The GEE framework was also used to estimate the effect of change in word familiarity (1–4) on the probability of lexical success for all four study groups. Figure 5 illustrates that in the presence of low word familiarity levels (1–2.5), the TDH group had the highest probability of success, while the other groups showed a very low probability to achieve correct lexical scores. However, as familiarity levels increased (2.5–4), the probability of success rose steeply for the TDL, LIH and LIL groups. The gap between study groups gradually declined with increasing familiarity levels, finally closing in the highest rates.

Discussion

This is a study investigating the effects of language impairment and SES background on lexical learning in Hebrew across the school years, with four study groups: typically developing children and young adolescents from mid-high (TDH)

[5] Familiarity effects on lexical scores were analyzed by the Generalized Estimating Equation (GEE) procedure, which estimates coefficients as they vary across participant repeats, and controls for participant effect across individual measurements, as each measurement is nested within a participant (Twisk, 2013). The model was carried out on the lexical score according to all independent variables (study groups, schooling levels, and lexical categories), as shown in Table 7.

Table 7 GEE logistic regression results for word familiarity effects on correct lexical scores, divided by study group, schooling level and lexical category

	Lexical score (%)	Familiarity rates	b	SE	Exp (b)	Percent
Whole sample	40.0	2.88 (.75)	.60***	.03	1.83	83
G1 + G2	20.0	2.75 (.74)	1.04***	.09	2.82	182
G3 + G4	37.0	2.75 (.74)	.58***	.05	1.78	78
G5 + G6	51.4	2.75 (.74)	.60***	.05	1.82	82
G7 + G8	59.5	3.52 (.49)	.44***	.11	1.56	56
TDH	53.5	2.88 (.75)	.56***	.04	1.74	74
TDL	38.0	2.88 (.75)	.70***	.12	2.02	102
LIH	32.1	2.88 (.75)	.74***	.06	2.08	108
LIL	22.1	2.88 (.75)	1.64***	.27	5.17	417
Nouns	20.7	3.23 (.66)	.93***	.08	2.55	155
Verbs	50.9	3.34 (.63)	1.51***	.04	4.51	351
Adjectives	35.3	2.78 (.81)	.51***	.04	1.66	66
TDH						
Nouns	28.1	3.23 (.66)	.48***	.10	1.62	62
Verbs	64.5	3.34 (.63)	1.78***	.08	5.96	496
Adjectives	52.1	2.78 (.81)	.36***	.05	1.43	43
TDL						
Nouns	20.9	3.23 (.66)	1.38***	.15	3.98	298
Verbs	49.6	3.34 (.63)	1.57***	.07	4.81	381
Adjectives	30.9	2.78 (.81)	.48***	.07	1.62	62
LIH						
Nouns	14.4	3.23 (.66)	1.30***	.22	3.67	267
Verbs	42.5	3.34 (.63)	1.56***	.09	4.77	377
Adjectives	27.0	2.78 (.81)	1.04***	.10	2.83	183

Table 7 continued

	Lexical score (%)	Familiarity rates	b	SE	Exp (b)	Percent
LIL						
Nouns	10.0	3.23 (.66)	2.55***	.43	12.75	1175
Verbs	31.5	3.34 (.63)	1.55***	.12	4.72	372
Adjectives	15.1	2.78 (.81)	.77***	.33	2.15	115

Familiarity effects on lexical scores were analyzed by the Generalized Estimating Equation (GEE) procedure. For every specific sub-sample (4 study groups, 4 schooling levels, and 3 lexical categories), Table 7 reports mean correct lexical scores; mean familiarity levels (on a scale of 1–4, where 1 = Non-familiar, 4 = Very familiar); logistic regression coefficient (b); the probability to achieve a correct score over the probability of failure (Exp. B); and the percent change in the probability of achieving a correct score for each one unit of change in word familiarity. For example, the level of correct score over the whole sample is 40%, while the mean familiarity level over the whole sample is 2.88. The probability of achieving a correct score over the probability of failure is 1.83 greater, that is, if word familiarity increases by one unit, the probability of achieving a correct score increases by 83%

and low SES (TDL) backgrounds, and their language impaired peers, again from mid-high (LIH) and low SES (LIL) backgrounds. Participants were asked to derive verbs, adjectives and derived abstract nouns on the basis of source words from other lexical classes. Each response was scored as a whole word (lexical score), and according to its base (root or stem) and affix (pattern or suffix) morphemes. Results indicate similarities and differences between language impairment and low SES, and in particular highlight the "double jeopardy" situation of language difficulties coupled with a disadvantaged background.

General findings

All analyses testify to the long developmental route of the Hebrew content lexicon, even when learning conditions are optimal. Three systematic hierarchies emerged in our study. First, a consistent pattern of achievements was revealed, where the typically developing high SES group (TDH) always scored the highest, the language impaired low SES group (LIL) always scored the lowest, pointing to the combined adverse effects of language difficulties and disadvantaged environment; while the typically developing low SES (TDL) and the language impaired mid-high SES (LIH) lay in-between, often showing no differences. Second, in all study groups verbs scored the highest and derived abstract nouns the lowest, with adjectives lying in-between. Finally, across all study groups and lexical categories, the base morpheme (root or stem) scored higher than the affix morpheme (pattern or suffix).

Study groups

As predicted, the TDL, LIH and LIL groups not only had lower scores, but also showed slower learning paces which often led to widening gaps between groups with increasing grade level. The overall picture emerges may suggest a different developmental pattern presented by the four study groups. Whereas the TDH group showed the steepest developmental curve throughout gradeschool with generally no further development towards middle school, the TDL and LIH groups presented a slower but consistent development throughout all age range. The LIL group showed the slowest learning pace and least development (if any) amongst all study groups. As a result, even after eight years of schooling and literacy studies, the TDL, LIH and LIL groups were still at a disadvantage regarding morpho-lexical abilities. However, contrary to our prediction, the TDL group did not outscore the LIH group in most analyses, but rather demonstrated a similar developmental picture, with equivalent attainments by middle school. Thus, while findings support previous studies showing that language development is impeded extensively by both language impairment and environmental deprivation (Farah et al., 2006; Hoff & Tian, 2005; Joffe & Nippold, 2012; Silliman & Berninger, 2011), they also suggest that in the long run, language impairment and SES factors may have similar outcomes on achieving age appropriate morpho-lexical knowledge.

These results are supported by the familiarity analyses. As expected, all four groups performed better on highly familiar items. However, the TDL and LIH groups, and in particular the LIL group, were more affected by familiarity, showing

extremely low lexical scores at low familiarity levels and a steeper rise in success as familiarity levels increased. This implies a lack in compensatory resources available to the TDH group, such as morphological knowledge which enables identifying structural and semantic connections between words. Since findings also point to a bigger contribution of familiarity to lexical success at younger ages, it appears that the less advanced the learners, the more they lean on words familiarity.

Verbs, nouns and adjectives

As expected, lexical category scores differed across the study groups. The lexical analysis showed that verbs had the highest starting point and fastest learning rates across all four groups, however with consistently lower scores in the TDL and the two LI groups. This was the only category where gaps among study groups decreased with grade level. By gradeschool, verbs proved to be the least diagnostic category in our study. Moreover, verb familiarity was the highest across categories and made the most contribution to correct scores in all study groups except the LIL. Derived abstract nouns proved to be the hallmark of late acquisition, with very low starting points for all groups, the slowest learning curves and the lowest achievements by middle school, with growing discrepancies between the four study groups. This category was specifically difficult for the three groups, with the TDL and LIH showing development only between nonconsecutive age groups and the LIL showing no development at all. The TDL and LIH, and in particularly the LIL, gained more than the TDH group from abstract noun familiarity. Adjectives had an interim status between verbs and abstract nouns, and were most affected by population type. Thus, while TDH fifth to sixth graders already obtained similar scores for adjectives and verbs, the TDL, LIH and LIL groups presented similar developmental trajectories for adjectives and derived abstract nouns, with increasing discrepancies among study groups by middle school. With the lowest familiarity values on the task, adjective familiarity contributed the least to correct performance in all study groups.

The content word hierarchy is attributed to semantic and Hebrew specific structural properties of verbs, adjectives and abstract nouns. Verbs, the smallest and most tightly-knit derivational system in Hebrew, are the prototypical habitat of root-and-pattern structure. Verbs are thus the first content word class and derivational system class to emerge in Hebrew, serving as a platform for learning word formation (Armon-Lotem & Berman, 2003; Ravid et al., 2016a). In contrast, derived nouns, expressing concepts, ideas and processes, are morphologically complex in Hebrew, constructed on simpler verbs and adjectives (Berman & Seroussi, 2011). The fact that the nouns selected for the current study were all morphologically irregular compounded the challenge for all study groups, and especially for the TDL, LIH and LIL. The interim status of adjectives is explained by their being relational words, conveying the semantic properties of nouns (Blackwell, 2005). Structurally, Hebrew adjectives are less uniform than verbs, with three different morphological compositions, as shown above (Bolozky, 1999). They consequently constitute a low frequency class in both developing and adult lexicons (Bar-Ilan & Berman, 2007; Ravid & Levie, 2010; Ravid et al., 2016b). Altogether, our findings

are in line with previous studies that showed that less linguistically proficient populations, such as L2 learners and LI students, exhibit poor adjectival abilities (Polinsky, 2004; Ravid et al., 2003; Tribushinina & Dubinkina, 2012), suggesting adjectives as a diagnostic proxy of vocabulary richness (Best, Dockrell, & Braisby, 2006; Marinellie & Kneile, 2012; Ravid, 2004).

Morphological development

The study points to the central role of both base (roots, stems) and affix (patterns, suffixes) morphemes in acquiring the Hebrew content word lexicon. As expected, bases preceded affixes across all lexical categories and study groups. The base-affixal gap closed by middle school only in the TDH and only for adjectives. Furthermore, discrepancies between study groups in correct root responses in verbs and abstract nouns gradually decreased with grade level, leaving only the LIL behind by early adolescence. Taken together, these findings indicate that even in the presence of language impairment or environmental deprivation, Hebrew speakers search for meanings within the Semitic consonantal root or the complex word stem, which provide the basic lexical reference of the word (Berman, 2012; Deutsch & Meir, 2011; Ravid, 2012).

Affixes had poorer starting points and lower scores for all study groups, with consistent gaps between TDH and the rest of the groups. In the more challenging categories of adjectives and abstract nouns, these differences widened with grade level. Patterns and suffixes provide the categorical classification of the Hebrew word, essential for constructing distinct word representations within the same root- or stem-based families (Bar-On & Ravid, 2011; Boudelaa & Marslen-Wilson, 2000). Thus, while root *g–d–l* relates the verbs *gadal* "grow", *gidel* "raise", and *higdil* "enlarge", it is the *binyan* patterns which provide the final form and meaning of the verb. This is clearly illustrated by the fact that affix scores develop in tandem with lexical attainment across all categories and study groups. Learning the classificatory roles of affixes requires lexical quality in the sense of efficient command of lexical and morphological networks (Ravid, 2012; Ravid & Schiff, 2006b). Thus, not only is categorical knowledge a late comer to morphological development, it is also more vulnerable in the presence of limiting learning resources or environmental factors. This suggests that both low SES typically developing children and language impaired children are at a disadvantage in using this key morphological device in learning new vocabulary.

Conclusions

Our findings show that morpho-lexical knowledge in Hebrew is substantially impeded by both language impairment and SES factors, all the more so when these two factors are combined. This was particularly pronounced in the more abstract and specific vocabulary, and the more opaque morpheme of pattern. Our study suggests that children and adolescents with linguistic impairment and/or environmental deprivation experience difficulties in processing derivational morphology

information and in establishing morpho-lexical relationships among words. These difficulties are reflected in different learning patterns and widening gaps, and might result not only in restricted vocabulary, but also in less efficient word learning processes and low lexical quality of word representations (Perfetti, 2007).

Our findings also suggest a new perspective on the difficulties in lexical attainment. We showed clear evidence that typically developing participants from low SES and their linguistically disabled peers from mid-high SES greatly resembled each other in attainments and developmental patterns. Thus, findings testify not only to the effects of language impairment as an innate disorder (Tomblin & Nippold, 2014), but also to the cumulative and long term consequences of environmental deprivation (Fernald et al., 2013; Hoff, 2013). It seems that growing up in a poorer, less educated background, being exposed to less varied linguistic input and to limited opportunities of literacy activities (Hart & Risley, 2003; Rowe, 2008) indeed takes its toll.

References

Anglin, J. M. (1993). Vocabulary development: A morphological analysis. With commentary by G. A. Miller & P. C. Wakefield; and a reply by J. M. Anglin. *Monographs of the Society for Research in Child Development*, *58*(10, 238), i–186.

Armon-Lotem, S., & Berman, R. A. (2003). The emergence of grammar: Early verbs and beyond. *Journal of Child Language, 30*(4), 845–877. doi:10.1017/S0305000903005750

Balota, D. A., Pilotti, M., & Cortese, M. J. (2001). Subjective frequency estimates for 2,938 monosyllabic words. *Memory & Cognition, 29,* 639–647. doi:10.3758/BF03200465

Bar-Ilan, L., & Berman, R. A. (2007). Developing register differentiation: The Latinate-Germanic divide in English. *Linguistics, 45*(1), 1–36.

Bar-On, A., & Ravid, D. (2011). Morphological decoding in Hebrew pseudowords: A developmental study. *Applied Psycholinguistics, 32*(3), 553–581. doi:10.1017/S014271641100021X

Ben-Zvi, G., & Levie, R. (2016). Development of Hebrew derivational morphology from preschool to adolescence. In R. A. Berman (Ed.), *Acquisition and development of Hebrew: From infancy to Adolescence* (pp. 135–173)., TILAR (Trends in Language Acquisition Research) series Amsterdam: John Benjamins.

Berman, R. A. (1985). *Acquisition of Hebrew*. Hillside, NJ: Erlbaum.

Berman, R. A. (1993). Marking of verb transitivity by Hebrew-speaking children. *Journal of Child Language, 20*(3), 641–669.

Berman, R. A. (2007). Developing language knowledge and language use across adolescence. In E. Hoff & M. Shatz (Eds.), *Handbook of language development* (pp. 346–367). London: Blackwell Publishing.

Berman, R. A. (2012). Revisiting roots in Hebrew: A multi-faceted view. In M. Muchnik & Z. Sadan (Eds.), *Studies on modern Hebrew and Jewish languages in honor of Ora (Rodriguez) Schwarzwald* (pp. 132–158). Jerusalem: Carmel Press.

Berman, R. A., Nippold, M. A., & Ravid, D. (2007). *Developing language and discourse abilities in pre-adolescence: a cross-linguistic study of different populations*. Final report submitted to Israel-United States Binational Science Foundation (BSF): Jerusalem.

Berman, R. A., & Ravid, D. (2010). Interpretation and recall of proverbs in three pre-adolescent populations. *First Language, 30*(2), 155–173. doi:10.1177/0142723709359246

Berman, R. A., & Seroussi, B. (2011). Derived nouns in Hebrew: Structure, meaning, and psycholinguistic perspectives. *Italian Journal of Linguistics, 23*(1), 105–125.

Bertram, R. A., Hyönä, J., & Laine, M. (2011). Morphology in language comprehension, production and acquisition. *Language and Cognitive Processes, 26*(4–6), 457–481. doi:10.1080/01690965.2011.559102

Best, R. M., Dockrell, J. E., & Braisby, N. (2006). Lexical acquisition in elementary science classes. *Journal of Educational Psychology, 98*(4), 824–838.

Black, E., Peppe, S., & Gibbon, F. (2008). The relationship between socio-economic status and lexical development. *Clinical Linguistics and Phonetics, 22*(4–5), 259–265. doi:10.1080/02699200801918887

Blackwell, A. A. (2005). Acquiring the English adjective lexicon: relationships with input properties and adjectival semantic typology. *Journal of Child Language, 32*(3), 535–562. doi:10.1017/S0305000905006938

Bolozky, S. (1999). *Measuring productivity in word formation: The case of Israeli Hebrew*. Boston: Brill.

Boudelaa, S., & Marslen-Wilson, W. (2000). Non-concatenative morphemes in language processing: Evidence from Modern Standard Arabic. *Proceedings of the Workshop (ITRW) on Spoken Word Access Processes, 1,* 23–26. Nijmegen: Max Planck Institute.

Brizzolara, D., Gasperini, F., Pfanner, L., Cristofani, P., Casalini, C., & Chilosi, A. M. (2011). Long-term reading and spelling outcome in Italian adolescents with a history of specific language impairment. *Cortex, 47*(8), 955–973. doi:10.1016/j.cortex.2011.02.009

Carlisle, J. F. (2010). Effects of instruction in morphological awareness on literacy achievement: An integrative review. *Reading Research Quarterly, 45*(4), 464–487. doi:10.1598/RRQ.45.4.5

Carlisle, J. F., & Katz, L. A. (2006). Effects of word and morpheme familiarity on reading of derived words. *Reading and Writing, 19*(7), 669–693. doi:10.1007/s11145-005-5766-2

Colombo, L., Pasini, M., & Balota, D. A. (2006). Dissociating the influence of familiarity and meaningfulness from word frequency in naming and lexical decision performance. *Memory & Cognition, 34*(6), 1312–1324.

Craig, H. K., & Washington, J. A. (2000). An assessment battery for identifying language impairments in African American children. *Journal of Speech, Language, and Hearing Research, 43*(2), 366–379. doi:10.1044/jslhr.4302.366

Davis, M. H., & Gaskell, M. G. (2009). A complementary systems account of word learning: Neural and behavioral evidence. *Philosophical Transactions of the Royal Society B, 364*(1536), 3773–3800.

Deacon, S. H., Whalen, R., & Kirby, J. R. (2011). Do children see the danger in dangerous? Grade 4, 6, and 8 children's reading of morphologically complex words. *Applied Psycholinguistics, 32*(3), 467–481. doi:10.1017/S0142716411000166

Deutsch, A., Frost, R., & Froster, K. I. (1998). Verbs and nouns are organized and accessed differently in the mental lexicon: Evidence from Hebrew. *Journal of Experimental Psychology. Learning, Memory, and Cognition, 24*(5), 1238–1255.

Deutsch, A., & Meir, A. (2011). The role of the root morpheme in mediating word production in Hebrew. *Language and Cognitive Processes, 26*(4–6), 716–744. doi:10.1080/01690965.2010.496238

Engel de Abreu, P. M., Cruz-Santos, A., & Puglisi, M. L. (2014). Specific language impairment in language-minority children from low-income families. *International Journal of Language & Communication Disorders, 49*(6), 736–747. doi:10.1111/1460-6984.12107

Farah, M. J., Shera, D. M., Savage, J. H., Betancourt, L., Giannetta, J. M., Brodsky, N. L., et al. (2006). Childhood poverty: Specific associations with neurocognitive development. *Brain Research, 1110*(1), 166–174.

Farkas, G., & Beron, K. (2004). The detailed age trajectory of oral vocabulary knowledge: Differences by class and race. *Social Science Research, 33*(3), 464–497. doi:10.1016/j.ssresearch.2003.08.001

Fazio, B. B. (1999). Arithmetic calculation, short-term memory, and language performance in children with specific language impairment: A 5-year follow-up. *Journal of Speech, Language, and Hearing Research, 42*(2), 420–431.

Fernald, A., Marchman, V. A., & Weisleder, A. (2013). SES differences in language processing skill and vocabulary are evident at 18 months. *Developmental Science, 16*(2), 234–248. doi:10.1111/desc.12019

Gaskell, M. G., & Ellis, A. W. (2009). Word learning and lexical development across the lifespan. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1536), 3607–3615.

Ginsborg, J. (2006). The effects of socio-economic status on children's language acquisition and use. In J. Clegg & J. Ginsborg (Eds.), *Language and social disadvantage: Theory into practice* (pp. 9–27). London: Wiley.

Goulandris, N. K., Snowling, M. J., & Walker, I. (2000). Is dyslexia a form of specific language impairment? A comparison of dyslexic and language impaired children as adolescents. *Annals of Dyslexia, 50*(1), 103–120.

Hackman, D. A., & Farah, M. J. (2009). Socioeconomic status and the developing brain. *Trends in Cognitive Sciences, 13*(2), 65–73. doi:10.1016/j.tics.2008.11.003

Hart, B., & Risley, T. R. (2003). The early catastrophe: The 30 million word gap by age 3. *American Educator, 27*(1), 4–9.

Hoff, E. (2013). Interpreting the early language trajectories of children from low-SES and language minority homes: Implications for closing achievement gaps. *Developmental Psychology, 49*(1), 4–14. doi:10.1037/a0027238

Hoff, E., & Tian, C. (2005). Socioeconomic status and cultural influences on language. *Journal of Communication Disorders, 38*(4), 271–278.

Hora, A., Avivi Ben-Zvi, G., Levie, R., & Ravid, D. (2007). Acquiring diminutive structures and meanings in Hebrew: An experimental study. In I. Savickiene & W. U. Dressler (Eds.), *The acquisition of diminutives* (pp. 295–317). Amsterdam: John Benjamins.

Jarmulowicz, L., & Taran, V. L. (2013). Lexical morphology: Structure, process, and development. *Topics in Language Disorders, 33*(1), 57–72.

Joffe, V. L., & Nippold, M. A. (2012). Progress in understanding adolescent language disorders. *Language, Speech, and Hearing Services in Schools, 43*(4), 438–444.

Kieffer, M. J. (2012). Before and after third grade: Longitudinal evidence for the shifting role of socioeconomic status in reading growth. *Reading and Writing, 25*(7), 1725–1746. doi:10.1007/s11145-011-9339-2

Kornilov, S. A., Magnuson, J. S., Rakhlin, N., Landi, N., & Grigorenko, E. L. (2015). Lexical processing deficits in children with developmental language disorder: An event-related potentials study. *Development and Psychopathology, 27*(2), 459–476. doi:10.1017/S0954579415000097

Kuperman, V., & Van Dyke, J. A. (2013). Reassessing word frequency as a determinant of word recognition for skilled and unskilled readers. *Journal of Experimental Psychology: Human Perception and Performance, 39*(3), 802–823. doi:10.1037/a0030859

Landauer, T. K., & Dumais, S. T. (1997). A solution to Plato's problem: The latent semantic analysis theory of acquisition, induction and representation of knowledge. *Psychological Review, 104*(2), 211–240.

Landauer, T. K., Kireyev, K., & Panaccione, C. (2011). Word maturity: A new metric for word knowledge. *Scientific Studies of Reading, 15*(1), 92–108. doi:10.1080/10888438.2011.536130

Larsen, J. A., & Nippold, M. A. (2007). Morphological analysis in school-age children: Dynamic assessment of a word learning strategy. *Language, Speech and Hearing Services in Schools, 38*(3), 201–212. doi:10.1044/0161-1461(2007/021)

Lawrence, J. F., Capotosto, L., Branum-Martin, L., While, C., & Snow, C. E. (2012). Language proficiency, home-language status, and English vocabulary development: A longitudinal follow-up of the Word Generation program. *Bilingualism: Language and cognition, 15*(3), 437–451. doi:10.1017/S1366728911000393

Leonard, L. B. (2014). *Children with specific language impairment*. Cambridge, MA: MIT press.

Lesaux, N. K., Kieffer, M. J., Faller, S. E., & Kelley, J. G. (2010). The effectiveness and ease of implementation of an academic vocabulary intervention for linguistically diverse students in urban middle schools. *Reading Research Quarterly, 45*(2), 196–228. doi:10.1598/RRQ.45.2.3

Llauradó, A., & Tolchinsky, L. (2013). Growth of text-embedded lexicon in Catalan: From childhood to adolescence. *First Language, 33*(6), 628–653. doi:10.1177/0142723713508861

Mainela-Arnold, E., Evans, J. L., & Coady, J. A. (2008). Lexical representations in children with SLI: Evidence from a frequency-manipulated gating task. *Journal of Speech, Language, and Hearing Research, 51*(2), 381–393. doi:10.1044/1092-4388(2008/028)

Manz, P. H., Hughes, C., Barnabas, E., Bracaliello, C., & Ginsburg-Block, M. (2010). A descriptive review and meta-analysis of family-based emergent literacy interventions: To what extent is the research applicable to low-income, ethnic-minority or linguistically-diverse young children? *Early Childhood Research Quarterly, 25*(4), 409–431.

Marinellie, S. A., & Kneile, L. A. (2012). Acquiring knowledge of derived nominals and derived adjectives in context. *Language, speech, and Hearing Services in Schools, 43*(1), 53–65. doi:10.1044/0161-1461(2011/10-0053)

Marshall, C. R., & Van Der Lely, H. K. J. (2007). Derivational morphology in children with grammatical-specific language impairment. *Clinical Linguistics and Phonetics, 21*(2), 71–91. doi:10.1080/02699200600594491

McGregor, K. K., Oleson, J., Bahnsen, A., & Duff, D. (2013). Children with developmental language impairment have vocabulary deficits characterized by limited breadth and depth. *International Journal of Language and Communication Disorders, 48*(3), 307–319. doi:10.1111/1460-6984.12008

Moats, L. C., & Smith, C. (1992). Derivational morphology: Why it should be included in language assessment and instruction. *Language, Speech and Hearing Services in Schools, 23*(4), 312–319.

Nagy, W. E., Carlisle, J. F., & Goodwin, A. P. (2014). Morphological knowledge and literacy acquisition. *Journal of Learning Disabilities, 47*(1), 3–12. doi:10.1177/0022219413509967

Nagy, W. E., & Townsend, D. (2012). Words as tools: Learning academic vocabulary as language acquisition. *Reading Research Quarterly, 47*(1), 91–108. doi:10.1002/RRQ.011

Nation, K., Snowling, M. J., & Clarke, P. (2007). Dissecting the relationship between language skills and learning to read: Semantic and phonological contributions to new vocabulary learning in children with poor reading comprehension. *International Journal of Speech-Language Pathology, 9*(2), 131–139. doi:10.1080/14417040601145166

Nippold, M. A. (2002). Lexical learning in school-age children, adolescents and adults: A process where language and literacy converge. *Journal of Child Language, 29*(2), 474–478.

Noble, K. G., Norman, M. F., & Farah, M. J. (2005). Neurocognitive correlates of socioeconomic status in kindergarten children. *Developmental Science, 8*(1), 74–87. doi:10.1111/j.1467-7687.2005.00394.x

Perfetti, C. A. (2007). Reading ability: Lexical quality to comprehension. *Scientific Studies of Reading, 11*(4), 357–383. doi:10.1080/10888430701530730

Polinsky, M. (2004). Word class distinctions in an incomplete grammar. In D. Ravid & H. Bat-Zeev Shyldkrot (Eds.), *Perspectives on language and language development. Essays in honor of R. A. Berman*. Dordrecht: Kluwer.

Purcell-Gates, V., & Dahl, K. L. (1991). Low-SES children's success and failure at early literacy learning in skills-based classrooms. *Journal of Literacy Research, 23*(1), 1–34. doi:10.1080/10862969109547725

Rabin, J., & Deacon, H. (2008). The representation of morphologically complex words in the developing lexicon. *Journal of Child Language, 35*(2), 453–465. doi:10.1017/S0305000907008525

Ravid, D. (2003). A developmental perspective on root perception in Hebrew and Palestinian Arabic. In Y. Shimron (Ed.), *Language processing and acquisition in languages of semitic, root-based morphology* (pp. 293–319). Amsterdam: Benjamins.

Ravid, D. (2004). Later lexical development in Hebrew: Derivational morphology revisited. In R. A. Berman (Ed.), *Language development across childhood and adolescence: Psycholinguistic and crosslinguistic perspectives* (pp. 53–82). Amsterdam: Benjamins.

Ravid, D. (2006a). Semantic development in textual contexts during the school years: Noun scale analyses. *Journal of Child Language, 33*(4), 791–821. doi:10.1017/S0305000906007586

Ravid, D. (2006b). Word-level morphology: A psycholinguistic perspective on linear formation in Hebrew nominals. *Morphology, 16*(1), 127–148. doi:10.1007/s11525-006-0006-2

Ravid, D. (2012). *Spelling morphology: The psycholinguistics of Hebrew spelling*. New York: Springer.

Ravid, D., Ashkenazi, O., Levie, R., Ben Zadok, G., Grunwald, T., Bratslavsky, R., et al. (2016a). Foundations of the early root category: Analyses of linguistic input to Hebrew-speaking children. In R. A. Berman (Ed.), *Acquisition and development of Hebrew: From infancy to adolescence* (pp. 95–134). Amsterdam: John Benjamins.

Ravid, D., & Avidor, A. (1998). Acquisition of derived nominals in Hebrew: Developmental andlinguistic principles. *Journal of Child Language*, 25(2), 229–266.

Ravid, D., Bar-On, A., Levie, R., & Douani, O. (2016b). Hebrew adjective lexicons in developmentalperspective: Subjective register and morphology. *The Mental Lexicon*, *11*(3), 401–428. doi:10.1075/ml.11.3.04rav

Ravid, D., Ben-Zvi, G., & Levie, R. (1999). Derivational morphology in SLI children: Structure andsemantics of Hebrew nouns. In M. Perkins & S. Howard (Eds.), *New directions in languagedevelopment and disorders* (pp. 39–49). New York: Plenum.

Ravid, D., & Levie, R. (2010). Adjectives in the development of text production: Lexical, morphological and syntactic analyses. *First Language*, *30*(1), 27–55. doi:10.1177/0142723709350529

Ravid, D., Levie, R., & Ben-Zvi, G. (2002). The role of language typology in linguistic development: Implications for the study of language disorders. In Y. Levy & J. Schaeffer (Eds.), *Language competence across populations: Toward a definition of SLI* (pp. 183–207). Mahwah, NJ: Erlbaum.

Ravid, D., Levie, R., & Ben-Zvi, G. (2003). Morphological disorders. In L. Verhoeven & H. Van Balkom (Eds.), *Classification of developmental language disorders: Theoretical issues and clinical implications* (pp. 235–260). Mahwah, NJ: Erlbaum.

Ravid, D., & Nir, M. (2000). On the development of the category of adjective in Hebrew. In M. Beers, B. Van den Bogaerde, G. Bol, J. De Jong, & C. Rooijmans (Eds.), *From sound to sen-tence: Studies on first language acquisition* (pp. 113–124). Groningen: Center for Language and Cognition.

Ravid, D., & Schiff, R. (2006a). Morphological abilities in Hebrew-speaking gradeschoolers from two socio-economic backgrounds: An analogy task. *First. Language, 26*(4), 381–402. doi:10.1177/0142723706064828

Ravid, D., & Schiff, R. (2006b). Roots and patterns in Hebrew language development: Evidence from written morphological analogies. *Reading and Writing, 19*(8), 789–818. doi:10.1007/s11145-006-9004-3

Rowe, M. L. (2008). Child-directed speech: Relation to socioeconomic status, knowledge of child development and child vocabulary skill. *Journal of Child Language, 35*(1), 185–205. doi:10.1017/S0305000907008343

Rowe, M. L., Raudenbush, S. W., & Goldin-Meadow, S. (2012). The pace of vocabulary growth helps predict later vocabulary skill. *Child Development, 83*(2), 508–525. doi:10.1111/j.1467-8624.2011.01710.x

Schiff, R., Cohen, M., Ben-Artzi, E., Sasson, A., & Ravid, D. (2016). Auditory morphological knowledge among children with developmental dyslexia. *Scientific Studies of Reading, 20*(2), 140–154.

Schiff, R., & Lotem, E. (2011). Social class differences in the development of reading ability: The role of phonological awareness and morphological awareness within two orthographies. *First Language, 31*(2), 131–163. doi:10.1177/0142723710393098

Schiff, R., & Ravid, D. (2007). Morphological analogies in Hebrew-speaking university students with dyslexia compared with typically developing gradeschoolers. *Journal of Psycholinguistic Research, 36*(3), 237–253. doi:10.1007/s10936-006-9043-6

Schmitt, N. (2014). Size and depth of vocabulary knowledge: What the resear shows. *Language Learning, 64*(4), 913–951. doi:10.1111/lang.12077

Silliman, E. R., & Berninger, V. W. (2011). Cross-disciplinary dialogue about the nature of oral and written language problems in the context of developmental, academic, and phenotypic profiles. *Topics in Language Disorders, 31*(1), 6–23. doi:10.1097/TLD.0b013e31820a0b5b

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research, 75*(3), 417–453. doi:10.3102/00346543075003417

Snow, C. E. (2010). Academic language and the challenge of reading for learning about science. *Science, 328,* 450–452. doi:10.1126/science.1182597

Sparks, A., & Reese, E. (2013). From reminiscing to reading: Home contributions to children's developing language and literacy in low-income families. *First Language, 33*(1), 89–109. doi:10.1177/0142723711433583

Sun, L., & Nippold, M. A. (2012). Narrative writing in children and adolescents: Examining the literate lexicon. *Language, Speech, and Hearing Services in Schools, 43*(1), 2–13. doi:10.1044/0161-1461(2011/10-0099)

Swisher, L., & Snow, D. (1994). Learning and generalization components of morphological acquisition by children with SLI: Is there a functional relation? *Journal of Speech and Hearing Research, 37*(6), 1406–1413.

Tomblin, J. B., & Nippold, M. A. (2014). *Understanding individual differences in language development across the school years*. New York: Psychology Press.

Tribushinina, E., & Dubinkina, E. (2012). Adjective production by Russian-speaking children with specific language impairment. *Clinical Linguistics & Phonetics, 26*(6), 554–571. doi:10.3109/02699206.2012.666779

Twisk, J. W. R. (2013). *Applied longitudinal data analysis for Epidemiology*. Cambridge: Cambridge University Press.

Verhoeven, L., & Perfetti, C. A. (2011). Introduction to the special issue: Vocabulary growth and reading skill. *Scientific Studies of Reading, 15*(1), 1–7. doi:10.1080/10888438.2011.536124

Walker, D., Greenwood, C., Hart, B., & Carta, J. (1994). Prediction of school outcomes based on early language production and socioeconomic factors. *Child Development, 65*(2), 606–621.

Whitehouse, A. J., Line, E. A., Watt, H. J., & Bishop, D. V. (2009). Qualitative aspects of developmental language impairment relate to language and literacy outcome in adulthood. *International Journal of Language & Communication Disorders, 44*(4), 489–510. doi:10.1080/13682820802708080

Wolter, J. A., & Green, L. (2013). Morphological awareness intervention in school-age children with language and literacy deficits: A case study. *Topics in Language Disorders, 33*(1), 27–41.

Yoshikawa, H., Aber, J. L., & Beardslee, W. R. (2012). The effects of poverty on the mental, emotional, and behavioral health of children and youth: Implications for prevention. *American Psychologist, 67*(4), 272–284. doi:10.1037/a0028015

Zuzovsky, R., & Olshtain, E. (2008). *The attainment of reading literacy in Israel (PIRLS 2006)*. Tel Aviv: Ramot. (in Hebrew).