

The vowel path

Learning about vowel representation in written Hebrew

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This study probes Hebrew-speaking children's knowledge about vowel representation by diacritics and by vowel letters in emergent literacy stages, and how this knowledge changes with formal instruction in first grade. Sixteen kindergartners and sixteen first graders were administered two reading tasks, two meta-linguistic explanation tasks, and two writing tasks involving vowels in different phonological and orthographic constructions and morphological roles. The results show that kindergartners already have some knowledge about writing consonants, and proceed to meaningful reading and writing in first grade through learning about writing vowels. Reading and writing syllables were easier than word reading and writing in kindergarten, and converged in first grade. Explaining vowel differences in words was better than in syllables, since children made use of the lexical context. Learning to represent morphemes at word final position by vowel letters emerged gradually in kindergarten, in the following order: H, standing for *a* and *e*, then W and Y, representing *o*, *u* and *i*. The development of vowel letters is shown to be dependent on a variety of considerations — orthographic, morphological, phonological, and perceptual. These results are discussed in the context of general theories about the consolidation of spelling.

1. Introduction

“No system of writing is ever so perfect as to be able to reproduce the sounds of a language in all their various shades, and *The Writing of the Semites* has one striking fundamental defect, viz. that only the consonants (which indeed form the substance of the language) are written as real letters” W. Gesenius (1910, p.5)

This is how Gesenius, a 19th century German scholar of Biblical Hebrew, defined the problem that is at the heart of this paper: Representing vowels in

the essentially vowelless Hebrew script. The current paper tackles this problem from a psycholinguistic, developmental perspective, focusing on the special role of vowels in the early stages of learning to read and write in Modern Hebrew.

In different languages, vowels are more problematic for readers, and particularly for poor readers, than consonants (Frost & Bentin, 1992; Landerl, Wimmer, & Frith, 1997; Purushothama, 1990). Vowel errors constitute a large part of children's spelling errors in English (Treiman, 1993), and are motivated by phonological considerations (Ehri, Wilce, & Taylor, 1987). Varnhagen, Boechler, and Steffler (1999) found that English-speaking children progress from using phonological 'best-guess' strategies to gradually relying on analogical orthographic information in spelling ambiguous vowel phonemes.

Recent studies indicate that vowel spelling and reading pose an even more acute problem to speakers of Hebrew and Arabic, due to the essentially consonantal nature of the Semitic script and the secondary morphological functions of vowels (Ravid, 2005). For example, vowel spelling is acquired later and with more difficulty than consonant spelling in Hebrew (Ravid & Kubi, 2003; Share & Levin, 1999). The Hebrew vowel letter *W* ן standing for *o* and *u* was shown to have an ambiguous status in the perception of adult readers, and to be easily omitted in certain contexts by literate adults (Ravid & Schiff, 2004; Schiff & Ravid, 2004a). In Arabic too, vowels have been shown to have a special grammatical and orthographic status and to pose problems for readers (Abu Rabia, 1996; 1997; 2001).

Vowel marking has broader implications for general processing theories beyond the psycholinguistics of Semitic orthographies. Katz and Frost (2001) adopt the view that reading and spelling interface in their dependence on *both* graphemic and phonological information rather than on one to the exclusion of the other. They propose that spelling knowledge is thus to a certain extent a function of the readers' ability to recognize spelling patterns following multiple exposures to these patterns. According to this view, the stability of a single letter is a function of the simplicity of the grapheme-phoneme relation: A stable memory trace of a spelling pattern is the result of a simpler link between phonology and orthography, which requires less processing before a decision is made about the phonemic value of the letter. As we are going to show below, vowel marking in Hebrew is unstable, and learning to read and spell Hebrew vowels is particularly difficult because of the instability and under-determination of the grapheme — phoneme link.

1.1 Historical sources of Hebrew vowel representation

Hebrew orthography started out as purely consonantal (Coulmas, 1989). In one historical change, the letters AHWY (Hebrew אָהוּי) were assigned additional vocalic values in Mishnaic Hebrew as *matres lectionis* ‘mothers of reading’, to indicate vowels between consonant letters in a manner similar to Greek and Latin (Bendavid, 1971). While vowel letters facilitated consonantal reading, this system was not precise and consistent enough. A fuller and more consistent system of vowel marking was introduced into Hebrew in the 7th and 8th centuries CE (Khan, 1997; Rendburg, 1997). This system (known as *nikud*, also called vocalization, voweling, punctuation) consists of diacritics placed mainly under (and also above and within) letters.

1.2 Modern Hebrew orthography

Modern Hebrew orthography is mainly consonantal, reflecting its fundamental Semitic root-based underpinnings: 18 of the 22 letters indicate consonants alone, while the four *matres lectionis* אָהוּי AHWY have a double consonant-vowel function (Coulmas, 1989; Ravid, 2005). Consonants are the more stable part of the written Hebrew word, since each and every consonant is represented in writing, while vowels are under- and inconsistently represented, especially in word-medial position (see below).

1.2.1 *Vowel diacritics in reading and writing*

Modern Hebrew employs two versions of the same orthography, one shallow and transparent, and another — deep and opaque. The full and transparent version is the *vocalized* orthography, which represents both consonants and vowels. This version provides precise phonological information about the written Hebrew word. In addition to the full representation of all consonants by all letters, the five vowels *a, e, i, o, u* are represented by 9 diacritic *nikud* marks, combining to form 13 marks. Thus each Modern Hebrew vowel has at least two, in some cases three, corresponding written signs.¹ For a detailed analysis of *nikud* marking and Modern Hebrew vowels, see Ravid (2005). Vocalized orthography with *nikud* marking is restricted to two contexts: (i) initial reading and writing instruction, and consequently texts for novice readers — children’s books and texts for new immigrants; (ii) Biblical and poetic texts, where vocalization ensures precise reading. In addition, vocalization is sometimes used to disambiguate words and to provide phonological information about foreign words in standard non-vocalized texts.

For the initial stages of learning to read, the phonologically full and transparent *nikud* marking seems to be very helpful (Navon & Shimron, 1984) and results in early and rapid decoding skills in Hebrew (Share & Levin, 1999: 96). A number of reports confirm that accurate reading of vocalized Hebrew words with *nikud* diacritics in first grade is already about 80% (Geva & Siegel, 1991; Geva, Wade-Woolley, & Shany, 1993; Shatil, Share, & Levin, 2000). With this in view, all reading materials for novice readers (children and non-native speakers alike) are presented with *nikud*. But as soon as children are able to decode Hebrew words, they stop relying on *nikud* diacritics in their reading texts (Frost, 1992; Shimron, 1993; 1999). Gradeschool teachers report that the majority of the children do not know the names of *nikud* diacritics, and many do not know how to map them onto the corresponding vowels. It is only in highschool, as a result of intense focus on meta-morphological manipulation of written and spoken isolated words, that *nikud* marks regain some prominence and knowledge in students (Ravid, 1996; Ravid & Shlesinger, 2001).

In contrast to this U-shaped developmental curve of using *nikud* diacritics in reading, what we have learned from writing studies so far is that at no point in development do Hebrew non-expert writers willingly use *nikud*. At the very time preschoolers and first graders are relying heavily on vocalized script in learning to read, they almost completely shun it in writing (Levin & Korat, 1993). In later years even this sparse usage of *nikud* in writing declines. Gradeschoolers rarely employ diacritics in their written texts (Berman & Ravid, 1999; Kaplan, in preparation), and even educated adults (e.g., kindergarten teachers) are unwilling to write using *nikud*. Vocalized texts are produced only by highly trained individuals with specialized knowledge in formal Hebrew grammar (Ravid, 2005).

1.2.2 *AHWY* vowel letters

Despite its phonological under-specification, the non-vocalized orthography is the default version of written Hebrew, and is used across the board for literacy activities, including school instruction from about 4th grade onwards (Share & Levin, 1999). The use of such a skeletal orthography obviously necessitates heavy reliance on distributional, morphological, syntactic and discourse context cues (Shimron, 1993; 1999).

The *non-vocalized* orthography represents all consonants by all letters, while vowels are partially and ambiguously represented by the vowel letters *AHWY* אהוּי, which serve a double function as designators of consonants and vowels (Table 1). For example, both initial consonantal (or rather, semi-vowel) *y* and final vowel *i* in the word *yalduti* 'childish' are represented by the letter *Y*

Table 1. AHWY letters designating consonants and vowels

Latin Grapheme	Hebrew Grapheme	As V letters	As C letters	Constraints on occurrence as V letter
A	א Alef	a,e	?	Word-final (unless root)
H	ה He	a,e	h	Word-final
W	ו Vav	o,u	v	No constraints Inconsistent
Y	י Yod	i	y	No constraints Inconsistent ³

י in the written string YLDWTY ילדוּתִי. Table 1 shows the current status of AHWY letters in Modern Hebrew orthography.

Vowel representation by AHWY is far from consistent and systematic. A subset of two vowels (*a,e*) are both represented by two vowel letters (A,H ה א) and are almost never marked word-internally (except for cases where A א stands for a root letter). Therefore written strings such as *mélex* ‘king’ and *malax* ‘ruled’ do not contain any vowel letters, and appear in their bare consonantal form as MLK מלך. Not only are homophonous strings such as this numerous in Hebrew (Bar-On, in preparation), they also promote thinking of words as consonantal roots by demoting the perceived status of internal vowels (Schiff & Ravid, 2004b).

A second subset of three vowel letters displays different behavior: the two vowels *o,u* are represented by one letter (W ו), while *i* is marked by the letter Y י. These three vowels (*o, u,* and *i*) are marked both word-internally and in final position, e.g., *kotev* ‘is writing’ spelled KWTB כותב, and *pakid* ‘clerk’ spelled PQYD פקיד. Taken together, AHWY אהוּי as vowel letters fall into two groups: AH אה and WY וי, differing in their vocalic values and orthographic distribution. While AHWY אהוּי are usually obligatory at word-final position in both orthographic versions (vocalized and non-vocalized), Y י and W ו are marked in many cases in word-internal positions.

1.3 Word-final vowels with morphological functions

The rich and varied morphological constructs of Hebrew are systematically and consistently reflected in its orthography (Ravid, 2001, 2005). Of the four vowel letters, H, W and Y have morphological functions as both root and function vowel letters, while A only represents root vowels. Especially relevant for

this paper are several inflectional morphemes which appear at the end of the Hebrew words. In most cases, these final vowels bearing morphemic value are represented by letters rather than by diacritic marks even in non-vocalized script. Thus, H ך stands for the vowels *a* and *e*, which denote grammatical gender in various lexical categories. For example, in *tmuna* ‘picture’ (TM-WNH), *kosa* ‘her-glass’ (KWSH), *yafa* ‘pretty, FEM’ (YPH), and *bona* ‘builds, FEM’ (BWNH) the final vowel *a* represented by written H indicates feminine gender; whereas in *more* ‘teacher’ (MWRH) and *bone* ‘builds’ (BWNH) the final vowel *e* represented by H indicates masculine gender. W stands for both final *u* and *o*, again bearing morphological functions. For example, final *u* in *banu* ‘built’ (BNW) indicates plural number, and *o* in *bo* ‘in-it’ (BW) indicates masculine gender. Finally, Y stands for first person in *li* ‘to-me’ (LY) and for second person, feminine gender in imperative *kni* ‘buy’ (QNY).

2. The study

Against this background, we were interested in finding out how Hebrew-speaking children perceive and learn to read and write vowels despite their inconsistent and often unstable marking. Our study aimed to probe children’s knowledge about vowel representation by diacritics and by vowel letters in emergent literacy stages, and how it changes with formal instruction in first grade.

2.1 Population and procedure

The population of this study consisted of 32 children—16 kindergartners (aged 5–6) and 16 first graders (6–7), half boys and half girls, all monolingual speakers of Hebrew from middle/high socio-economic status. They were tested orally and individually at their schools at the end of the school year. The kindergartners had not had any formal reading and writing instruction prior to being tested, while the first graders had received intensive reading and writing instruction in school.

2.2 Materials

Study materials consisted of six tasks: Two reading tasks, two meta-linguistic explanation tasks, and two writing tasks. The study tasks highlighted vowels in their different orthographic forms and morphological roles, and downplayed consonants, which took a back seat, so to speak, in the current study. We used

as few consonants as possible to facilitate and scaffold the reading and writing tasks, and varied the vowels and their orthographic forms in order to assess children's knowledge and perception of them.

2.2.1 Reading tasks

The reading tasks focused on children's comprehension of written vowel signs. They aimed to determine whether children were able to isolate and read vowels written by diacritics and by AHWY in words and in syllables.

1. Reading syllables with diacritic marks. Participants were asked to read ten CV syllables based on two letters, with five different diacritic marks. For example, *re*, *ra* and *ru*, spelled רֶ רָ רֹ, all based on the letter R ר. The aim of this task was to assess children's ability to read diacritic vowels in simple syllabic strings without the scaffolding of word semantics.
2. Reading words with diacritic marks. Participants were asked to read six vocalized words based on the roots meaning 'write' and 'tell'. For example, *katuv* 'written' spelled KTWB כָּתוּב; and *mixtav* 'letter', spelled MKTB בְּכִתָּב. The aim of this task was to assess children's ability to read vowels (both as AHWY letters and as diacritic marks) with consonants.

2.2.2 Meta-linguistic explanation tasks

The meta-linguistic explanation tasks aimed to see to what extent children were able to identify and explicitly discuss the role of vowels in syllables and words.

3. Explaining homographic syllables. Participants were asked to read and explain the difference between members of two CV pairs sharing the same letter, which differed in their diacritic marking. For example, *ša* vs. *šo* שָּׂא vs. שָּׂו sharing the letter Š. The aim of this task was to assess children's awareness of the function of diacritics in expressing the phonological difference between the two syllables.
4. Explaining homographic words. Participants were asked to read and explain the difference between members of two pairs of homographic words, which differed only in their diacritic marking. For example, *mispar* 'number' spelled MSPR מִסְפָּר and *mispar* 'number' spelled MSPR מִסְפָּר share the same letter sequence. The different vocalization of each word is expressed in its different diacritics. The aim of this task was to focus on the vowel structure of the word and to assess children's awareness of the function of diacritics in expressing this structure.

2.2.3 Writing tasks

The writing tasks paralleled the reading tasks in structure (words vs. syllables), and focused on children's production of vowel signs in their writing from phonological, orthographic and morphological aspects.

5. Writing homographic syllables. Participants were asked to write two CV pairs sharing the same letter, which differed in their diacritic marking. For example, *ra* vs. *ro* רָוּ רֹ sharing the letter R. The aim of this task was to see how children would choose to represent vowels in simple syllabic strings.
6. Writing vowels with morphological roles in words. Participants were asked to write 15 words ending with the letters HWY וֹיָהּ, all of which have non-root morphological roles. The task words were classified into five sets according to their ending: (i) *a* feminine singular ending, e.g., *tmuna* 'picture', final vowel spelled H הֵ; (ii) *e* masculine singular ending, e.g., *bone* 'builds', final vowel spelled H הֶ; (iii) *i* first person singular ending, e.g., *baniti* 'I built', final vowel spelled Y יִ; (iv) *o* third person masculine singular ending, e.g., *ito* 'with-him', final vowel spelled W וֹ; (v) *u* plural ending on verbs, e.g., *halxu* 'they-went', final vowel spelled W וּ

2.2.4 Pilot study

Before embarking upon the actual study, we carried out a pilot investigation in two 5-year-old children to see if the tasks were appropriate for their age and literacy level. Having found that indeed the tasks did not produce a ceiling nor floor effect, we proceeded with the actual study in the population described above.

2.2.5 Predictions

Obviously, formal instruction in first grade was expected to improve performance in all study facets. Our main interest lay in developmental changes in vowel perception and presentation. We hypothesized that reading, a comprehension task, would be easier than writing, a production task, and that metalinguistic explanation would be the most difficult of the three task types. Regarding linguistic units, we thought syllable writing and reading would be easier than word writing, which requires more integrated skills. Regarding phonological units, we predicted that consonants would emerge earlier than vowels in reading and writing. We specifically predicted that judging and writing vowels in syllables and words would be difficult for kindergartners and easier for first graders. Regarding specific vowels, we thought that *a* reading would be easier than other vowels, following observation by many teachers and parents. But we

did not really have much to predict about the developmental path of learning about diacritics and vowel letters, given that this is the first systematic study of emergent literacy in the domain of vowel representation.

2.2.5 Scoring

Each task was scored separately on the consonants and the vowels comprising the items. The scoring scales were developed by the two authors (a linguist and a speech pathologist), applied to participants' responses, and revised until they could accommodate all responses. Scoring was conducted by the authors separately on 100% of the material and results were compared between the two scorers. Agreement between the two judges was 94%. In case of controversy the case was discussed until agreement was reached. Scoring scales are presented and discussed in the results section describing each task.

3. Results

Since results are analyzed in depth by category, we first present success scores on the six tasks (converted to percentages) in Figure 1.

3.1 Phonological segments in reading and writing linguistic units

Table 2 presents the data on reading and writing phonological segments (consonants and vowels) in two kinds of linguistic units: syllables and words. This

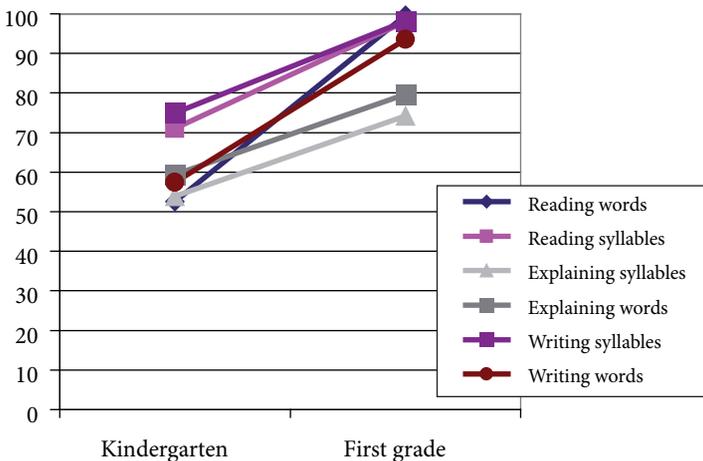


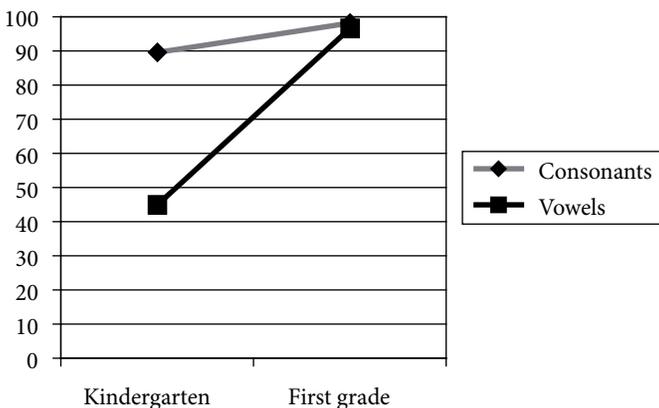
Figure 1. Task results in the two age groups.

Table 2. Mean percentages and standard deviations (SD) of reading and writing consonants and vowels in syllables and in words, by group

Age group	Consonants				Vowels			
	Syllables		Words		Syllables		Words	
	Reading	Writing	Reading	Writing	Reading	Writing	Reading	Writing
Kindergartners (5–6)	90.42 (13.33)	100	92.92 (12.09)	74.84 (5.33)	41.88 (25.09)	50 (30.43)	51.04 (19.88)	36.83 (37.58)
First graders (6–7)	99.38 (2.5)	100	100	93.09 (3.02)	95.94 (7.12)	96.35 (6.06)	99.48 (0.93)	94.44 (9.21)

analysis does not include the meta-linguistic explanation tasks. Sources of interactions were tested by Bonferroni post-hoc analyses. Findings reported were significant at the Bonferroni-adjusted alpha level.

A four-way analysis of group (2) x task (2: reading, writing) x linguistic unit (2: syllable, word) x phonological segment (2: consonants, vowels) on the data in Table 2 showed, counter to our prediction, no effect for task nor any interaction with any of the other variables — reading does not differ from writing in either age group. Performance on all tasks improves with age from 67.24% in kindergarten to 97.33% in first grade ($F(1,130) = 121.77, p < .001$). Also, linguistic units differed ($F(1,30) = 5, p < .005$): performance on syllables ($M = 84.25\%$) was higher than on words ($M = 80.33\%$), as predicted. An effect for phonological segment ($F(1,30) = 104.26, p < .0001$) showed that consonants were easier to read and write ($M = 93.83\%$) than vowels (70.75%). An interaction ($F(1,130) = 90.61, p < .001$) of age group and phonological unit (Figure 2) showed that the difference between consonants and vowels derives only from

**Figure 2.** Interaction between age group and phonological segment (consonants vs. vowels).

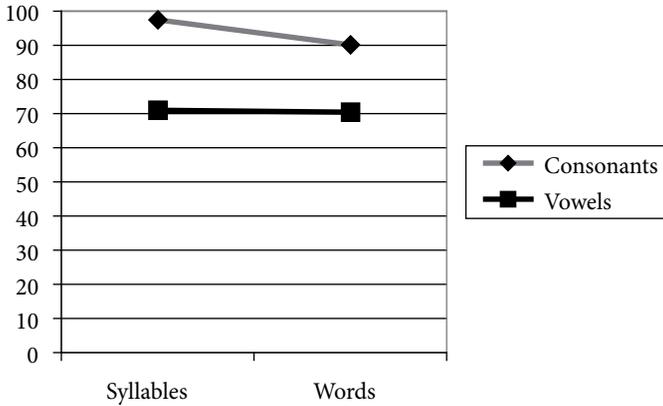


Figure 3. Interaction between linguistic and phonological segments (syllables and words, consonants and vowels).

the kindergartners. In first grade children do equally well on both phonological units.

A second interaction ($F(1,30)=9.38$, $p<.005$) of linguistic unit and phonological segment (Figure 3) showed that reading and writing consonants in syllables was easier than reading and writing vowels, but in words this difference was smaller.

A three-way interaction ($F(1,30)=9.09$, $p<.006$) of task \times linguistic unit \times age group found more success in reading words and writing syllables in kindergarten, but no such differences in first grade. This interaction is shown as part of the data presented in Figure 1.

We now turn to a detailed in-depth analysis of vowel reading and writing in each of the study tasks.

3.2 Reading vowels in syllables

The first task consisted of reading cards with 10 CV syllables based on two consonants — *r* and *š*, each time with a different diacritic standing for one of the five vowels in Hebrew *a*, *e*, *i*, *o*, *u*. Following observation, we predicted that *a*-reading should be earlier and more successful than reading other vowels. A two-way ANOVA (group \times phonological segment) found effects for age group ($F(1,30)=95.97$, $p<.0001$) and for phonological segment ($F(1,30)=20.69$, $p<.0001$): Reading *a* was easier than reading other vowels. The interaction of group and phonological unit ($F(1,30)=11.64$, $p<.003$) clearly showed that it was kindergartners who read *a* much better ($M=59.38\%$, $SD=45.53\%$) compared with other vowels ($M=10.16\%$, $SD=15.29\%$); while first graders

read *a* with 100% success and syllables with other vowels with similar results ($M = 92.97\%$, $SD = 13.67\%$).

Since there were almost no errors in first grade, we proceeded to analyze erroneous vowel reading in kindergarten. There were two major types of errors — no vowel reading ($M = 36.25\%$), and reading the consonant with an erroneous vowel (43.75%). These two error types did not differ statistically. In principle, each vowel could be erroneously read as four other vowels. A one-way analysis found an effect for error type ($F(1,15) = 13.68$, $p < .003$), showing that *a* attracted more errors ($M = 27.5\%$, $SD = 23.8$) than the other vowels (*e*: $M = 3.13\%$, $SD = 6.02$; *i*: $M = 6.88\%$, $SD = 16.62$; *o*: $M = 2.5\%$, $SD = 5.77$; *u*: $M = 3.75\%$, $SD = 8.06$).

3.3 Reading vowels in words

As we have already seen, kindergartners read consonants better than vowels in words, and first graders make almost no errors of either type. Our analysis thus focuses on errors in kindergartners' vowel reading.

We classified vowel reading errors in kindergarten into four major types: (1) Word read as sequence of letters without any vowels, e.g., *siper* 'told' read as *samex*, *pe*, *resh* (= S, P, R); (2) Vowel letter read as consonant, e.g., *u* in *sipur* 'story' read as *v*; (3) Erroneous vowel from a different orthographic domain, i.e., *a* or *e* substituted for *i, o, u* and vice versa, or *i* substituted for *o, u* or vice versa (see 1.2.1 and Table 1 above); and (4) Erroneous vowel from the same orthographic domain, e.g., *a* read as *e* or *o* read as *u*.

A one-way analysis showed that the differences between error types were significant ($F(3,45) = 7.1$, $p < .002$). Errors were ranked in the following descending order: Vowel read as consonant (type 2: 33.33% ($SD = 13.94$) > Erroneous vowel from the same domain (type 4: 25% ($SD = 17.74$) > No vowel (type 1: 15.1% ($SD = 21.78$) > Erroneous vowel from a different domain (type 3: 5.21% ($SD = 7.98$)).

3.4 Explaining vowels in homographic syllables

This task in fact had three parts: It required participants (i) to read two pairs of syllables differing only in diacritic marking (*re* versus *ra*, and *še* versus *ša*), (ii) to say whether the two syllables were the same or different, and (iii) to explain the difference between homographic pair members. As we predicted, syllable reading in this task improves dramatically from kindergarten to first grade from 23.44% (24.95) to 98.44% (6.25), and this difference is significant

($t(16.9) = 11.66, p < .01$). But counter to our prediction, there was no significant difference between the two groups in judging whether the syllable pairs were different: Both kindergartners (93.75%) and first graders (100%) were highly successful in their judgment scores.

We thus focus on the third component of this task, explaining the difference in vowel writing between homographic syllables. Responses were classified into five categories: (1) No explanation provided; (2) Inappropriate phonological explanation (*this ra is a longer sound, the other ra is a shorter sound*); (3) Inadequate explanation (e.g., *there are points here, and here there is a small D*); (4) Partial explanation — either orthographic or phonological (e.g., *they have different sounds; this is ša and this is š and there are 3 points here and another point*); (5) Full explanation focusing on the relationship of diacritics to vowel phonology (e.g., *this is re and this is ra, and the nikud is different and the reading is different*).

In both groups, *no explanation* responses were almost completely absent ($M = 6.25\%$, $SD = 25\%$ in kindergartners, $M = 3.13\%$, $SD = 12.5\%$ in first graders); *inappropriate phonological explanations* were also negligible ($M = 6.25\%$, $SD = 25\%$ in kindergartners, 0 in first graders); *inadequate explanations* were numerous in kindergarten ($M = 53.13\%$, $SD = 46.44\%$) and fewer in first grade ($M = 12.5\%$, $SD = 22.36\%$); *partial explanations* were found in both groups ($M = 34.38\%$, $SD = 43.66\%$ in kindergarten, $M = 65.63\%$, $SD = 35.21\%$ in first grade); and *full explanations* were completely absent in kindergarten, but not in first grade ($M = 18.75\%$, $SD = 30.96\%$).

A two-way analysis showed an effect for category type ($F(4,120) = 13.29, p < .0001$). This effect was mitigated by an interaction of group and category type ($F(4,120) = 5.93, p < .0001$), indicating that the number of inadequate explanations diminishes by 40% from kindergarten to first grade, while the number of partial explanations doubles. Full explanations, which are completely absent in kindergarten, reach almost 20% in first grade.

3.5 Explaining vowels in homographic words

This task too had three parts: It required participants (i) to read two pairs of words differing only in diacritic marking (*katav* ‘wrote’ versus *ktav* ‘writing’, both written as KTB כתב, with only diacritics to mark the difference); (ii) to say whether the two words were the same or different; and (iii) to explain the difference between them. As we predicted, word reading in this task improves dramatically from kindergarten to first grade from 9.38% ($SD = 15.48$) to 96.88% ($SD = 8.54$), and this difference is significant ($t(23,36) = 19.8, p < .01$).

But counter to our prediction, there was no significant difference between the two groups in judging whether the syllable pairs were different: Both kindergartners and first graders were 100% successful on their judgment scores.

We thus focus on the third component of this task, explaining the difference in vowel writing between homographic words. Responses were classified into four categories: (1) No explanation provided; (2) Inadequate explanation (e.g., *there is a line here, and here there is a line with a dot*); (3) Partial explanation — either orthographic or phonological (e.g., *it's the same word but this one with a dot is mi, you read it this way*); (4) Full explanation focusing on the relationship of diacritics to vowel phonology. In both groups, *no explanation* responses were almost completely absent (0 in kindergartners, $M = 6.25\%$, $SD = 25\%$ in first graders); *inadequate explanations* constituted the majority of kindergarten responses ($M = 62.5\%$, $SD = 46.55\%$), but were completely absent in first grade; *partial explanations* were found in both groups ($M = 37.5\%$, $SD = 46.55\%$ in kindergarten, $M = 56.25\%$, $SD = 40.31\%$ in first grade); and *full explanations* were absent in kindergarten, $M = 37.5\%$, $SD = 38.73\%$ in first grade.

A two-way analysis showed an effect for category type ($F(3,90) = 8.2$, $p < .0001$), mitigated by an interaction of group and category type ($F(3,90) = 11.29$, $p < .001$): Inadequate responses, which constitute most of the explanations in kindergarten, disappear in first grade, while the number of partial explanations almost doubles. Full explanations, which are completely missing in kindergarten, reach over one-third in first grade.

3.6 Writing homographic syllables

Participants had to write five CV syllables — *ra*, *ru*, *ri*, *še*, *šo*, and the bare consonant *š*. In principle, vowels can be expressed in writing in such contexts either as diacritic markings (e.g., writing *ra* as רַ), as AHWY letters (e.g., writing *ra* as רַר RH), or as both (רַרַ). We first examined children's success in writing the vowel correctly. Table 3 presents the data.

Table 3. Mean percentages and standard deviations (SD) of correct vowel writing in syllables by kindergartners and first graders

	<i>a</i>	<i>e</i>	<i>i</i>	<i>o</i>	<i>u</i>	No vowel
Age group						
Kindergartners	31.25	25	18.75	18.75	18.75	93.75
(5–6)	(47.87)	(44.72)	(40.31)	(40.31)	(40.31)	(25)
First graders	93.75	87.5	100	100	87.5	100
(6–7)	(25)	(34.16)			(34.16)	

Table 4. Mean percentages and standard deviations (SD) of types of vowel writing in syllables by kindergartners and first graders

Age group	No vowel	Invented vowel	Inappr. diacritic	Inappr. AHWY	Approp. diacritic	Approp. AHWY	Ap. HWY + diacritic
Kindergartners (5–6)	40 (48.44)	16.25 (33.64)	17.5 (31.73)	3.75 (10.88)	2.5 (6.83)	18.75 (34.62)	1.25 (5)
First graders (6–7)	2.5 (6.83)	0	3.75 (8.06)	0	57.5 (39.24)	18.75 (34.62)	17.5 (30)

We predicted that writing *a* would be easier than other vowels. A two-way analysis of group and vowel (including vowel absence) of the data in Table 5 showed an effect for vowel ($F(3,90) = 8.2, p < .0001$). Apart from the bare consonant, which is easiest ($M = 96.88\%$), children succeed most on writing *a* ($M = 62.5\%$), followed by *i* and *o* ($M = 59.38\%$), then *e* ($M = 56.25\%$), and finally *u* ($M = 53.13\%$).

We then proceeded to analyze how children choose to represent vowels when they write syllables. Writing vowels was classified into the following categories: (1) Absence of vowel representation; (2) Invented vowel marking, e.g., writing the letter grapheme higher on the page to mark *u*; (3) Inappropriate diacritic marking, e.g., writing one of the *e* diacritics for *a*; (4) Inappropriate AHWY marking, e.g., writing *i* by the letter א. (5) Appropriate diacritic marking; (6) Appropriate AHWY letter; (7) Appropriate AHWY letter with diacritic marking. Table 4 presents the distribution of these response types.

Beyond the effect for response category ($F(6,180) = 3.62, p < .003$), the important finding is the age group and category type interaction ($F(6,180) = 8.58, p < .001$), which essentially shows that vowel absence, invented vowel marking and inappropriate vowel marking by diacritics and AHWY disappear in the transition from kindergarten to first grade, writing vowels in syllables with AHWY does not change, and writing vowels with appropriate diacritics and AHWY increases.

3.7 Writing vowels with morphological roles in words

Vowels appearing at the end of the Hebrew word often have morphological roles. This task required children to write words ending with five vowels represented in writing by three of the vowel letters — HWY. Table 5 presents correct scores on writing final vowels: Responses scored as ‘correct’ included writing the correct vowel letter with or without appropriate or inappropriate diacritics.

Table 5. Mean percentages and standard deviations (SD) of correct writing of final vowels with morphological roles by kindergartners and first graders

	H for <i>a</i>	H for <i>e</i>	W for <i>o</i>	W for <i>u</i>	Y for <i>i</i>
Age group					
Kindergartners (5–6)	31.25 (47.87)	25 (44.72)	18.75 (40.31)	18.75 (40.31)	18.75 (40.31)
First graders (6–7)	93.75 (25)	87.5 (34.16)	100	100	87.5 (34.16)

Beyond the effect for group, there was an effect for HWY letter ($F(4,120) = 3.33, p < .02$). The following ranking order among letters: H standing for *a* ($M = 64.58\%$) > H standing for *e* ($M = 62.5\%$) > Y standing for *i* ($M = 57.29\%$) > W standing for *u* ($M = 48.96\%$) > W standing for *o* ($M = 46.88\%$). However only the easiest (H standing for *a*) and the most difficult (W standing for *o*) categories differed significantly.

3.7.1 *Writing vowels with morphological roles by diacritics*

Only first graders used appropriate diacritics in their writing. A one-way analysis of diacritic writing by vowel in first grade did not show any significant difference among them (*a*: $M = 45.83\%$, $SD = 48.5$; *e*: $M = 47.92\%$, $SD = 50.14$; *i*: $M = 35.42\%$, $SD = 44.67$; *o*: $M = 47.92\%$, $SD = 47.09$; *u*: $M = 43.75\%$, $SD = 46.7$).

3.7.2 *Writing vowels with morphological roles: error analysis*

This task required participants to write words with final vowels having morphological roles. Our analysis focused on vowel writing alone. Recall that the vowel letters AHWY fall into two different groups — AH and WY. In addition, recall that children sometimes perceive 9 ץ as a vowel letter due to its neutralization and merger with A א in the mainstream Hebrew dialect. Thus children may perform errors at different levels when writing HWY as vowel letters, which may tell us about their current perception of the system. For example, exchanging A for H is an error which makes sense, as they both stand for *a* and *e*, although A does not have a non-root morphological role; but writing YW for H is a more severe error, since YW have different orthographic and phonological functions than H, as shown above. We therefore analyzed the errors in writing each final vowel with morphological value by error level. The Appendix provides a full error analysis with the different scales for each vowel, as well as the results of two-way analyses of group x error type for each vowel.²

4. Discussion

This study is an initial developmental exploration of how Hebrew-speaking children perceive vowel representation in written Hebrew. Kindergartners and first graders were asked to read and write syllables and words. Their responses were analyzed in a developmental perspective focusing on the following three variables: (i) Task — reading, writing, and explanation; (ii) Linguistic unit — CV syllables and words; and (iii) Phonological unit — consonants and vowels.

4.1 Reading and writing different units in the transition to first grade

One general finding of this study is that children dramatically improve on all tasks in the transition from kindergarten to first grade. This might seem trivial at first glance: Israeli kindergartners do not receive any formal and systematic instruction in reading or writing, while first graders' main task at school is to learn to read and write. However, an in-depth analysis of the results yields far from obvious insights. First, as early as in kindergarten, Hebrew-speaking children are already able to read, write and discuss orthographic features of syllables and words to some extent, with response success ranging between 50–75%. Instruction in first grade brings reading and writing accuracy at the single word level to ceiling levels, a finding which is not necessarily shared by first grade populations speaking other languages, especially not in English (Geva & Siegel, 1991; Geva, Wade-Woolley, & Shany, 1993; Shatil & Share, 2003; Seymour, Aro, & Erskine, 2003). Taken together, these findings mean that by kindergarten Hebrew-speaking children possess a fair amount of knowledge about their writing system. However, as we show below, this knowledge consists mostly of information about consonants.

Our analysis of all six tasks shows that it is the swift and powerful influx of knowledge about vowels in first grade that dramatically ushers in meaningful reading and writing in Hebrew. All study tasks clearly show that the critical change from kindergarten to first grade is learning about vowel representation in the Hebrew orthography, as predicted. It might be claimed that we presented our participants with a smaller variety of consonants to read and write than vowels to begin with. This imbalance was, as pointed out above, deliberately introduced into our tasks, given that Hebrew vowel representation is much more complex, and less transparent and consistent than consonant representation (Ravid & Kubi, 2003; Ravid, 2005). Keeping this in mind, the detailed analyses of the study tasks clearly demonstrate that while consonant reading and writing is already well in place in our population at the end of kindergarten, the

two complementary devices expressing vowels in written Hebrew do not consolidate before the transition into formal literacy in first grade.

We predicted that reading, a comprehension skill, would be more advanced in the study population than writing, a more difficult production skill. Our results indicate that, counter our prediction, children succeed in reading and writing to the same degree. This finding is explained by the interesting balance between knowledge about Hebrew consonants and vowels required for reading and writing words and syllables. Kindergartners both read and write consonants much better than vowels, because the former are more visually prominent and carry more stable lexical information (Ravid, 2001; 2005). In view of the specific features of the Hebrew orthography, reading consonants alone, or with a single vowel (see below) does not yield a meaningful sequence, whereas writing without vowels often results in an acceptable Hebrew word (Schiff & Ravid 2004b, Ravid & Schiff 2004). Thus, vowel perception is what improves most in the transition to first grade, but it means much more for reading than for writing: Spoken vowels make a coherent Hebrew word in reading, while they only add an extra, often optional dimension in writing.

Another general finding, which only partially confirms our prediction, is the fact that CV syllable reading and writing is easier than word reading and writing in kindergarten, but by first grade the two linguistic units do not differ. One reason for this difference in kindergarten is statistical: Syllable reading and writing involved only two consonants, while word reading involved six consonants in two roots, and word writing involved 13 consonants. Given the under-representation of vowels in Hebrew script, the difference between the two units resides in the number of consonant graphemes that have to be written. Obviously, kindergartners find it easier to read and write a single grapheme to represent a syllable than a sequence of graphemes representing a word. It might be expected that this processing advantage of syllables over words would persist into first grade, with accurate, vowel-enhanced reading and writing of syllables being easier than that of words. However, by first grade children are able to cluster grapheme sequences together into coherent root morphemes (Ravid, 2003; Ravid & Malenky, 2001), and they already demonstrate an emerging ability to supply the vowel pattern which gives the word its composition and access its lexical meaning. Lexical context thus renders words more accessible constructs than syllables when literacy skills consolidate, despite their greater length and lesser transparency. This interpretation is supported by the fact that the consonant advantage over vowels is greater in syllables than in words, an indication that words are perceived as more integrated units than syllables, incorporating both phonological units into a single lexical unit.

4.2 Metalinguistic judgment and explanation

A special window on vowel representation is provided in this study by the metalinguistic explanation tasks, which required children to read, judge and explain the difference between homographic pairs of syllables and words, differing only in their vowels. The reading and judgment parts of this task reflect a frequently occurring situation in written Hebrew, where the vowel pattern often constitutes the only difference between two homographic grapheme strings (Bar-On, in preparation; Schiff & Ravid, 2004a). The difference is that the syntactic and discourse context, which is a powerful predictor of vowel patterns and word meaning in reading Hebrew (Shimron, 1993; 1999), is missing here, since our tasks focused on isolated syllables and words. This should be taken into account when interpreting our results: when a certain threshold is crossed, reading isolated Hebrew words might be more difficult than reading longer strings.

We made two separate predictions for these tasks. One was that on the whole, the explanation tasks would be more difficult than either reading and writing. Confirming our prediction, the explanation tasks scored the lowest and made less progress in both age groups, but interestingly, word explanation was easier than syllable explanation. This is further evidence for children's ability to make use of their vowel knowledge in lexical context: Relying on decoding skills alone to explain the difference between homographic CV syllables is less efficient than examining phonology-orthography relations in the context of lexical items using vowel patterns which delimit the search space. A second prediction was that kindergartners would find judging vowel differences between syllables and words more difficult than first graders. This prediction was completely refuted: Every single child in the study was able to say that the members in each pair differed from each other. The difference was in the types and levels of explanations provided.

4.3 Learning to represent vowels in written Hebrew

This study was designed to find out when and how children map out vowel space via vowel letters. The main focus of this study was on the two ancillary systems of writing vowels in Hebrew: AHWY vowel letters and the diacritic *nikud* system. Converging evidence from the six study tasks traces the route into vowel representation in written Hebrew.

4.3.1 *Emergent vowel reading*

One clear finding of this study is that while consonant representation is already well established in kindergarten and accounts for the relative success of children on all tasks, vowel representation lags far behind (Levin & Korat, 1993). For many kindergartners, the Hebrew orthography is vowelless. For example, over one third of the errors in reading syllables consisted of either pronouncing the bare consonant (e.g., *r*) or naming the letter (R ך as *resh*). Kindergartners' reading responses illustrate the fact that they do not understand the vocalic function of either of the two vowel systems — vowel letters and diacritics.

Vowel letters. One Hebrew solution for the 'striking fundamental defect' that Gesenius finds in the Writing of the Semites is the double role of AHWY as consonant and vowel letters. At this point of their reading development, children are aware only of the consonantal value of AHWY. Thus close to 50% of the errors in reading words consisted of no vowel reading, and of reading vowel letters as consonants (e.g., *v* for W ן instead of *o* or *u*) or as letter names (*vav*).

As we showed above, vowel letters AHWY fall into two separate groups, denoting different sets of vowels and having different orthographic constraints (Table 1). There are indications in this study that emergent perception of this split is already present in kindergartners, who tend to pool together erroneous vowels from the same group (e.g., *e* and *a*, *o* and *u*) in a quarter of the cases, rather than mixing vowels from different groups (only 5% of the cases).

Vowel diacritics (nikud). The diacritic system is as opaque for kindergartners as vowel letters. About two thirds of kindergartners' explanations of differences between syllable and word pairs do not represent understanding of the symbolic value of diacritics, which are described as dots and lines or given random names. Though all participants said that members of each pair were different, most kindergartners did not attribute the phonological difference to the change in diacritics. In contrast, partial and full explanations constituted the overwhelming majority of first graders' responses. It was clear that the grapho-phonemic relation between vowels and diacritics was already established in first grade: Children both knew diacritics' names and could relate them to the phonological difference between pairs of syllables or words. Their problem was often with the meta-linguistic formulation of vowel representation by diacritics, which was not optimal due to the young age and early literacy level of the participants.

Vowel perception does not emerge out of the blue. The major precursor of vowel reading in Hebrew is vowel *a* insertion. Syllables with *a* yielded about 60% correct reading responses, while syllables with all other vowels did not

yield over 10% correct reading. In addition, *a* was the preferred erroneous option in reading syllables. In word reading too, inserting *a* either at the end of the word or between consonantal graphemes occurred in close to 20% of the kindergartners' responses (e.g., *katavata* for *ktovet* 'address'). Inserting *a* constitutes a necessary bridge between vowelless script and developing vocalic reading: Children soon realize that reading does not consist of letter names alone and become aware of the integrated lexical function of words. Since natural languages, and Hebrew among them, require vowels for word pronunciation, children turn to *a* as the most frequent vowel in Hebrew (Bolozky, 1997), which frequently occurs in verbal and nominal patterns and is favored by Hebrew-speaking adults in lexical innovations (Ravid, 1990). We shall see that *a* is also the preferred vocalic option for vowel writing in Hebrew.

4.3.2 *Emergent vowel writing*

Vowel writing is a different task from vowel reading. Reading vowels in vocalized Hebrew involves interpreting a vowel letter, a diacritic, or their combination, whereas in writing one has to decide whether to write a vowel at all, and which vowel sign to use. The writing tasks we designed in this study channelled children towards writing vowels by focusing on the final phonological segment. Vowel writing in syllables required participants to write five CV syllables based on two consonants and five vowels, and a single bare consonant. Writing vowels in words presented children with 15 words ending in vowels with morphological values, conventionally written by vowel letters.

The path to writing vowels runs parallel in some respects to the path leading to vowel reading. Kindergartners had no problem writing the bare consonant where no vowel was required, but syllables with vowels were much harder to write. In such cases, they refrained from writing any vowel in 40% of the cases. Kindergartner marked vowels in syllables by diacritics in another 40% of the cases, but only about 4% were appropriate. Here, too, writing *a* emerges as an interim strategy to vowel writing. However, the difference between writing *a* (just over 30% correct responses) and the rest of the vowels (most under 20%) in kindergarten is not as dramatic as in the reading tasks. In contrast, close to 80% of the responses in first grade involved diacritics, and of these only under 4% were inappropriate. Interestingly, first graders alone asked the investigator whether they should write with diacritics. It is thus obvious that first grade literacy instruction, focused on CV syllables with differing vowels, ushers in knowledge about the vocalic function of diacritics.

AHWY vowel letters occur much more frequently at words' ends than within them (Table 1), since H and A are usually restricted to words' ends,

while Y and W do not always occur stably within words (Ravid, 2005; Schiff & Ravid, 2004a; b). As syllables usually form parts of words, the conventional way of writing vowels in single syllables would be diacritic signs rather than vowel letters. Indeed, in line with conventional syllable writing, neither kindergartners nor first graders made much use of vowel letters to signify syllable vowels (under 20%). But interestingly again, about the same number of responses in first grade involved marking vowels by the combination of appropriate vowel letter and diacritics.

4.3.3 *Learning to represent morphemes by vowel letters*

Our last task involved marking morphemic vowels at word-final position, which generally requires vowel letters. Only HWY were involved in this task, since A as a vowel letter has only root value. We found that kindergartners' performance here corresponds to our previous findings: H, standing for *a* and *e*, is written more successfully than W and Y, representing *o*, *u* and *i*. This perhaps reflects its more salient site at word-final position. By first grade, vowel representation is basically established.

The error analysis provided in the Appendix constitutes a window on the emergence of the vowel letters system in children. Most of the errors were made by kindergartners (12–14 in each case), whereas few first graders erred (2–6). Therefore, our analysis will focus mostly on kindergartners. What we were most interested in was whether children were able to make the distinction between the two subsets of vowel letters — H, A on the one hand, and Y, W on the other — in their errors. Regarding H as feminine and masculine marker (*a*, *e*), the most frequent error in kindergarten is no vowel marking, with about a quarter of the errors within the H, A (and 9) system. Only a negligible number of errors occurred outside this system, and very few children erred with H in first grade. This is in line with findings by other researchers (Levin & Korat, 1993).

Numerous erroneous responses in first grade involved writing WY vowel letters. Where Y was required, children did not mark any vowel option, added a redundant vowel letter at word end (e.g., YH) — or replaced it by a vowel letter from the H, A system. Where W was required, kindergartners represented *o* by the A,H system, and also by adding a redundant vowel letter at word end, e.g., writing *ito* 'with-him' as AYTWH אִיתוּהָ instead of AYTW אִיתוּ. These strategies almost totally replaced vowel omission in the six children who made errors in first grade. Where W was required to represent *u*, a small number of children replaced W by Y — a strategy which might be motivated by phonological considerations, since *i* and *u* are both high vowels, and both orthographically

consist of vertical lines with differing length. This strategy increased tenfold in first grade.

In sum, the development of vowel letters is dependent on a variety of considerations — orthographic, morphological, and phonological, and perceptual. H is the most perceptually salient vowel letter at word final position, and signifies the important and pervasive gender distinction. It is the first vowel letter to be acquired, and is not marked erroneously by YW vowel letters. H is in fact treated by both kindergartners and first graders as *the* prototypical vowel letter marking word final position, so that they are often not satisfied with W doing the job, and either replace it by H or add a redundant H after it.

4.4 Conclusion

This is the first study to systematically analyze how Hebrew-speaking children learn to read and write vowels in the transition from kindergarten to first grade. We have shown that kindergartners have good knowledge of consonant representation in the Hebrew orthography, but are only poised on the verge of acquiring knowledge about vowel representation in writing. It takes the whole of their first school year for them to work out a coherent and manageable picture of the two vowel systems of Modern Hebrew and make use of them in reading and writing.

The study has implications of two kinds. First, regarding Hebrew orthographic knowledge. This study joins previous research summarized in the introduction to highlight the different psycholinguistic status of consonants and vowels in reading and writing Hebrew. Knowledge of letters signifying consonants is robust and early emerging, while vowel marking by both diacritics and AHWY is difficult to learn, and to some extent, continues to challenge adults as well. Secondly, our findings are explained by the *resonance model* (Stone & Van Orden, 1994), a general theory for learning the relations between spelling and speech. According to this model, the covariance of orthographic and phonological events while recognizing spelling patterns is the main mechanism for strengthening the connections between those representations (Katz & Frost, 2001). Consistency in representing consonants and inconsistency in representing vowels underlie the learning patterns described in this paper. Hebrew AHWY have a more ambiguous relation to speech than graphemes which code consonants and are thus coded less effectively.

Notes

1. Diacritic marks also distinguish between the stop and spirant versions of the letters P, K, B פ, כ, ב.
2. Note that the age effects are irrelevant since the mean number of errors is constant.
3. In fact, the Academy of Hebrew has set specifications regarding the insertion of Y signifying the vowel *i* and the diphthong *ey*, however these require specialized knowledge in formal Hebrew which is not available to all speaker/writers.

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Appendix

Error analysis: Writing vowels with morphological roles (letters written both with and without diacritics)

	No vowel	<i>a</i> by Y ך, W ן	<i>a</i> by 9 ם	<i>a</i> by A ם
Group N = 15				
Kindergartners	69.3	7.69	2.56	20.51
N = 13	(48.04)	(27.74)	(9.25)	(39.76)
First graders	50	0	0	50
N = 2	(70.71)			(70.71)

1. Mean percentages and standard deviations of error types in writing morphological *a* by H ם at word-final position. The error type effect: $(F(4,52) = 3.79, p < .01)$.

	No vowel	<i>e</i> by Y ʹ, W ʌ	<i>e</i> by A ʌ
Group N = 15			
Kindergartners	69.44	2.78	27.78
N = 12	(43.71)	(9.62)	(44.57)
First graders	0	33.33	66.67
N = 3		(57.74)	(57.74)

2. Mean percentages and standard deviations of error types in writing morphological *e* by H ʌ at word-final position. The error type effect: $(F(4,52) = 3.84, p < .09)$.

	No vowel	C letter added	<i>i</i> by A ʌ, H ʌ, ʉ ʉ	Correct Y ʹ + V letter
Group N = 18				
Kindergartners	71.43	2.38	19.05	7.14
N = 14	(41.05)	(8.91)	(33.88)	(19.3)
First graders	25	0	75	0
N = 4	(50)		(50)	

3. Mean percentages and standard deviations of error types in writing morphological *i* by Y ʹ at word-final position. The error type effect: $(F(4,64) = 6.34, p < .001)$.

	No Vowel	C letter added	<i>o</i> by A ʌ, H ʌ, ʉ ʉ	Correct W ʌ + V letter
Group N = 20				
Kindergartners	64.29	7.14	21.43	7.14
N = 14	(40.22)	(14.19)	(36.06)	(19.3)
First graders	16.67	0	33.33	50
N = 6	(20.82)		(51.64)	(54.77)

4. Mean percentages and standard deviations of error types in writing morphological *o* at word-final position. 14 children in kindergarten and six in first grade made errors in representing *o* by W ʌ. The error type effect: $(F(4,72) = 4.49, p < .004)$.

	No Vowel	C letter added	<i>u</i> by A ʌ, H ʌ, ʉ ʉ	<i>u</i> by Y ʹ	Correct W ʌ + inappr. diacritics
Group N = 19					
Kindergartners	71.43	4.76	16.67	7.14	0
N = 14	(36.65)	(12.1)	(31.35)	(26.73)	
First graders	20	0	0	75.33	6.67
N = 5	(44.72)			(43.46)	(14.91)

5. Mean percentages and standard deviations of error types in writing morphological *u* by W ʌ at word-final position. The error type effect: $(F(4,68) = 7.77, p < .001)$.

