

# **Learning to spell in Hebrew: Phonological and morphological factors**

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**Running head: Hebrew spelling**

**Abstract****Learning to spell in Hebrew: Phonological and morphological factors**

This paper investigates children's developing knowledge of the Hebrew spelling system in view of the claim that language-specific typology affects the rate and the pattern of development of orthographic spelling. Hebrew is a morphologically synthetic language with a phonologically "deep" orthography, on the one hand, and a consistent representation of morphology in the spelling system, on the other. This paper focuses on the difference between representing content words versus grammatical words, and roots versus morphemic and attached function letters in written Hebrew. The paper describes two studies. In Study 1, compositions from gradeschool children (grade 1 through 6) were analyzed for types of spelling errors; in Study 2, children from grades 2-4 were administered a spelling task. Results indicate that grammatical words are spelled correctly before content words, and that within content words, the correct spelling of function letters precedes that of root letters. These differences are attributed to factors of transparency, consistency and frequency, coupled with gradeschoolers' growing perception of phonological and morphological patterning in Hebrew.

**Key words**

Hebrew, function letters, morphology, phonology, root letters, spelling.

**Abbreviations**

C = consonant

Pl = Plural number

Masc = Masculine gender

Sg = Singular number

Inf = Infinitival marker

Fm = Feminine gender      Fut = Future tense

### **Introduction: the interface of morphology and spelling**

The literature reports three major stages in children's acquisition of spelling in alphabetic orthographies: I *Pre-phonetic writing*, involving logographic or symbolic writing, with early pre-phonetic attempts; II *Phonetic writing*, essentially breaking the grapho-phonemic code which associates graphemes with phonemes (Goswami, 1999; Goswami & Bryant, 1990; Levin & Korat, 1993; Treiman, 1993); and III *Alphabetic* or "*conventional*" *writing*, which involves incorporating morphological components into the spelling (Ellis, 1994; Jones, 1991; Treiman, Zukowski & Richmond-Welty, 1995). The current study focuses on the role of morphological knowledge in the shift of spelling development in Hebrew from stage II to stage III.

The reciprocal relationship between knowledge of spelling in alphabetical systems and morphological knowledge has been the focus of a number of studies in the last few years (Fowler & Liberman, 1995; Levin, Ravid & Rappaport, 1999, in press; Nunes, Bryant & Bindman, 1997; Rubin, 1988). The growing interest in this area derives from an understanding of the task children face in learning to read and write, which consists of perceiving the relationship between the orthographic system being learned, the oral segments that it represents, and the typology of the language constructs represented. Most alphabetical orthographies are not "shallow" or transparent in the sense that they do not always directly represent surface phonological segments (Frost, 1992); rather, they reflect underlying phonological structures (Scholfield, 1994) as well as morphological units that may or may not coincide with phonological units (Blanche-Benveniste & Chervel, 1974; Derwing, 1992). For example, the English adjective suffix<sup>1</sup> *-ic* has 3 different phonetic values in *electric*,

*electricity*, and *electrician* (*k*, *s*, and *sh* respectively), but is spelled consistently with the same letters IC, formally representing its unity as a morphophonological (or a deep phonological) construct (Chomsky & Halle, 1968). Thus, it is clear that a basic step in learning to read and write is deciphering the surface grapho-phonemic code (Bentin, 1992; Bryant & Goswami, 1987; Goswami, 1999); yet it is also recognized that children must become aware of deep phonological segments in their language and their manifestation in the writing system, as has been shown, for example, for the case of Dutch orthographic geminates (Gillis & De Schutter, 1996; Gillis & Sandra, 1998). Children also have to perceive the morphological dimension of the orthography, and to map spoken morphological units onto written segments (Jones, 1991; Totereau, Theverin & Fayol, 1997). Such deep phonological as well as morphological perception contributes to success in the beginning phases of formal literacy acquisition (Carlisle, 1995; Carlisle & Nomanbhoy, 1993; Rubin, 1988). This is especially evident in studies comparing learning and reading-disabled children with normally achieving readers (Webster, 1994).

The different ways in which morphological knowledge bootstraps conventional spelling are related to the degree of morphological wealth in the language system, and to the prominence of morphological representation in the orthography (Bybee, 1995). For example, the novice English speller is not required to pay much attention to oral morphological information: the core, everyday English lexicon which children acquire early on is largely monomorphemic, with sparse inflectional morphology and little derivational morphology (Clark, 1993; Crystal, 1995). It is only in the higher school grades that English-speaking students typically encounter and learn to spell the bulk of the Graeco-Latinate vocabulary that consists of multimorphemic strings (e.g., *indefatigable*) and requires morphological analysis (Anglin, 1993; Henry, 1993; Tyler & Nagy, 1990). It takes several years for English-speaking children to integrate this information into their written representations (Bailet, 1990)

### Language typology and spelling: the case of Hebrew

Current studies of spelling acquisition trace children's growing understanding of the nature of written morphological representations. For example, young French spellers initially seek a one-to-one relationship between spoken and written representation, following the principle of transparency established as underlying other linguistic phenomena such as first-language acquisition and language change (Fayol, Largy & Lemaire, 1994; Ravid, 1995; Totereau, Theverin & Fayol, 1997). Language-specific traits also participate in the process of spelling development, as the present study intends to show. The conceptual basis of this paper is as follows: *Language-specific typology affects the rate and the pattern of development of orthographic spelling*. This means that orthographies will reflect features of the specific language typology. Relatedly, learning to represent morphological units in an alphabetical orthography is paced by the salience and regularity of morphological representation in that orthographic system (Gillis & Ravid, in press).

Hebrew offers an interesting case of a morphologically synthetic language with a phonologically "deep" orthography, on the one hand, and consistent representation of morphology in the spelling system, on the other. This paper presents evidence demonstrating the significance of these language-specific typological features in the acquisition of Hebrew spelling. It focuses on the difference between representing content words versus grammatical words, and roots versus morphemic and attached function letters in written Hebrew.

### Hebrew nonvocalized orthography

Hebrew employs two versions of the same orthography. One version, *vocalized* orthography, represents both consonants and vowels (Shimron, 1993). Consonants are represented by letters, vowels by diacritic marks as well as by letters. This version is used in reading and writing instruction, in children's books, in texts for new immigrants, and in

Biblical and poetic texts. Another version, *nonvocalized* orthography, represents all consonants, while vowels are partially and ambiguously represented by four letters (AHWY). Nonvocalized orthography is the default version of written Hebrew, used across the board for most purposes, including school instruction. While children's books are vocalized (up to about 4<sup>th</sup> grade), children themselves do not readily use vocalizing diacritics in their writing (Levin, Amsterdamer & Korat, 1997), and by 4<sup>th</sup> grade find them superfluous in reading as well (Ravid, 1996). The two studies described in this paper focus on nonvocalized spelling.

As a result of historical neutralizations, Modern Hebrew pronunciation does not bear a one-to-one relationship with its nonvocalized orthography. The latter has remained virtually unchanged for the last 2,000 years, and reflects phonological consistencies in earlier historical periods of Hebrew (Blau, 1971). There are two types of one-to-many relationships between current Hebrew phonology and nonvocalized spelling: Firstly, a number of phonemes are expressed each by two graphemes, reflecting historically distinct segments. For example, *t* is spelled as either ט *T* or as ת *T*<sup>2</sup> (Berman, 1997a; Bolozky, 1997). Conversely, three letters denote two distinct sounds, a stop and a spirant, e.g., the letter B indicates both the phonemes *b* and *v*.

After children succeed in breaking the grapho-phonemic code in Hebrew and learning which letters designate which sounds, their spelling is not yet orthographic or "correct": spelling errors typically occur in the 13 homophonous Hebrew letters which together designate 6 phonemes.

<i>t</i> = T ט T ת	? = H ה 9 ע ? א
<i>k</i> = K ק Q כ	<i>v</i> = W ו B ב
<i>x</i> = K כ H ה	<i>s</i> = Š ש S ס

For example, the word *merkava* 'carriage' was spelled by a third grader as MRQWH instead of MRKBH. Such spelling errors are found in the writing of Hebrew-speaking gradeschoolers

up to 6<sup>th</sup> grade (Eylon, 1992).

This might lead us to expect novice Hebrew spellers to make the same amount of spelling errors across the board in homophonous letters, with the factor of word frequency an aid in remembering word shapes and spelling patterns. The inconsistencies noted above, however, are only superficially phonology / spelling mismatches. In fact, they are critically affected by morphological representation, and reflect semantic and grammatical distinctions that children must attend to in order to learn to spell. As will be shown, the development of orthographic spelling is guided by perception of Hebrew morphology and its representation in different classes of words and of morphemes.

#### Spoken and written morphology in Hebrew

Hebrew expresses a broad range of lexical and grammatical categories in its morphology. The bulk of content words (all verbs, and most nouns and adjectives) are at least bi-morphemic, with two types of morphological constructions: (1) interdigitated consonantal root plus affixal pattern and (2) linearly concatenated stem and suffix. The first is the typically Semitic *nonlinear* structure involving a combination of a tri- or quadri-consonantal root, e.g., *s-g-r* ‘close’, and a vocalic pattern which may be preceded and or / followed by a consonant, e.g., the abstract noun pattern *miCCéCeʔ*<sup>3</sup>. These two are combined by interdigitating the root consonants in their designated sites in the pattern as in *misgéret* ‘frame’ (Berman, 1997a; McCarthy, 1982; Ravid, 1990, in press). Combining the same root *s-g-r* ‘close’ with other patterns yields past tense *sagar* ‘closed’, passive *nisgar* ‘was closed’, causative *hisgir* ‘betray into hostile hands’ and adjectival *sagur* ‘closed’, as well as *sgira* ‘closing’, *sgirut* ‘introvertness’, *séger* ‘closure’.

The second type of morphological structure in Hebrew is *linear*, a concatenation of a stem (typically a word) and a prefix or a suffix, e.g., *sagár-ti* ‘(I)-closed’. Several lexical noun categories are expressed by linear suffixes, e.g., *iton-ay* ‘journal-ist’, *iton-ut* ‘journal-

ism' (Berman, 1987, 1997a). All obligatory and optional grammatical markings of number, gender and person on nouns, adjectives and verbs are expressed linearly, e.g., *kadur-im* 'ball-s', *atsuv-ot* 'sad, Pl,Fm'.

As a result of this wealth of morphological structures, the core lexicon of Hebrew - nouns, verbs, and adjectives - is in many cases multimorphemic. Even everyday nouns such as *sock* and *watch* are internally complex: *gérev* 'sock' consists of the root *g-r-v* and pattern *CéCeC*; *sha'on* 'watch' is constructed of the stem *sha'a* 'hour' and the suffix *-on*. Inflections are not only widespread and numerous, but also phonologically salient, consisting of (usually) stressed syllables such as *-i*, *-a* or *-ot* (Blau, 1971; Ravid, 1995), e.g., *sus-a* 'mare', *sus-im* 'horses'. As a result, most of the words encountered by young Hebrew speakers are morphologically complex, and children are attuned from very early on to attend to word-internal structure. They start marking salient inflections, such as gender and number, as early as age two (Berman, 1981; Levy, 1980; Ravid, 1995, 1997). The basic derivational structure of Hebrew nouns, verbs and adjectives is learned between ages 3-6 (Berman, 1985; Clark & Berman, 1984; Ravid & Nir, in press), although mastery of semantically and structurally complex constructions is delayed to gradeschool age (Berman, 1993, 1997b; Ravid & Avidor, 1998).

Unlike content words, most Hebrew grammatical closed-class items<sup>4</sup> are usually monosyllabic and morphologically simplex. Consider the following examples:

Prepositions *im* 'with', *min* 'from', *be* 'in'

Conjunctions *ve* 'and', *o* 'or', *she* 'that', *ki* 'because'

Pronouns *ani* 'I', *at* 'you,Fm', *hu* 'he', *hen* 'they,Fm'

Quantifiers *kol* 'all', *ktsat* 'little', *rov* 'most'

Articles *ha-* 'the', *ze* 'this'

Several psycholinguistic studies of the development of morphological awareness in



spoken and written Hebrew have been carried out in recent years. Levin & Korat's (1993) study of early writing found emergent perception of written inflections (e.g., feminine singular *-a*) as early as kindergarten. In a study of morphological awareness (Ravid, in press; Ravid & Malenky, submitted), 100 children and adults were tested on awareness of various oral morphological constructs. The major finding was early sensitivity to the Semitic root and to inflectional suffixes, and later emergence of awareness of vocalic patterns and other derivational morphemes. Ephratt (1997) tested gradeschoolers and adults on root awareness by having them color letters within the word, and found that they consistently colored the root letters inside the words rather than using other strategies such as coloring initial or final letter sequences. Levin et al (1999, in press) found that awareness of linear morphemes typical of literate Hebrew (e.g., denominal adjectives and possessive marked nouns) increased significantly from kindergarten to first grade. All this shows clearly, as noted, that Hebrew speakers of all ages are sensitive to morphological structure.

#### Spelling Hebrew morphology

The highly synthetic nature of oral Hebrew is reflected in its nonvocalized written form. The written Hebrew word represents a variety of morphemes in fairly consistent ways. For example, *misgéret* 'frame', root *s-g-r*, *miCCéCet* pattern is spelled MSGRT, with the first and last letters designating the pattern, and the middle letters - the root (underlined). In addition, formal, literate Hebrew favors word-internal morphological constructions that are usually expressed as separate words in the spoken vernacular. For example, compare formal, written *xadr-o* 'room-his = his room' with informal, spoken *ha-xéder shelo* 'the-room his = his room'. Finally, Hebrew orthography attaches a number of letters designating grammatical words to the next word (see below). Thus written Hebrew words can consist of long strings of letters designating morphemes. For example, the written string *WKŠBMSGRTH* pronounced *u-xshe-be-misgart-a* and meaning 'and when in her frame' consists of the following

segments:

- |                       |   |
|-----------------------|---|
| 1. W = [u] ‘and’      | 4. MSGRT = [misgart] ‘frame [bound form]’ |
| 2. KŠ = [xshe] ‘when’ | 5. H = [a] ‘her’                          |
| 3. B = [be] ‘in’      |   |

Given this background, it is clear that Israeli children learning to read and write encounter morphologically complex words from early on. Learning to process written words has been shown to be related to literacy skills in Hebrew. Levin et al. (1999) tested 40 native Hebrew-speaking children in a longitudinal study from kindergarten to first grade on three late-emerging oral morphological constructions and on writing noun - adjective strings. They found a clear correlation between spoken morphology and writing ability: Spoken morphology and writing were found to correlate concurrently in kindergarten and in first grade, and predictively from kindergarten to first grade. In addition, each domain made an additional unique contribution to the change in the other from kindergarten to first grade. Spoken morphology and written word structure continue to be relevant in higher school grades. Ben-Dror, Bentin & Frost (1995) tested reading-disabled 5<sup>th</sup> graders together with an age-matched group and a vocabulary matched (3<sup>rd</sup> grade) group on phonological, semantic, and morphological skills. The reading-disabled children made the most mistakes and were the slowest to respond; and the most conspicuous difference between the groups was in the morphological test, most markedly in derivational morphology.

What Hebrew-speaking children have to learn is that Hebrew spelling represents underlying morphological consistencies obscured by surface pronunciation-spelling mismatches. The neutralizations of phonological distinctions in the spoken language described above disappear in the written language, which preserves the representation of phonological distinctions with morphological value.

Learning to spell in Hebrew involves constructing mental representations for systems of two kinds: *content words* versus *grammatical words*, and *root letters* versus *function letters*. Moreover, different systems yield different developmental patterns.

*Spelling content words and grammatical words.* Grammatical words are usually monomorphemic and morphologically simplex, so that learning which homophonous phoneme should be represented by which letter is a matter of rote learning or of associating spelling units with (full or partial) phonological strings (Seidenberg & McClelland, 1989). There is no internal morphological regularity governing these correspondences. But though their spelling may be idiosyncratic (e.g., *hu* ‘he’ spelled HWA), the number of grammatical words is small and they occur frequently and repetitiously in any kind of text, which should strengthen the links between phonological, syntactic and visual information. Content words, in contrast, are numerous and varied. Moreover learning content words involves paying attention to internal morphological regularities (e.g., root-and-pattern structure, described above), and to their written manifestations. Hence, one prediction is that grammatical words will be spelled correctly before content words. Another prediction is that within the class of content words, there will be a different learning pattern for root letters and for function letters, as explained below.

*Root letters.* The spoken Hebrew lexicon is essentially root-based, with word families sharing roots of 3 to 4 consonants which carry the main semantic content and structural core of the word, as shown above for root *s-g-r* ‘close’. For example, the root *d-r-k* ‘step’ appears as a consonantal skeleton (note alternating *k* and *x*) in the following words:

Verbs      *darax* ‘stepped’, *hidrix* ‘guided’, *hudrax* ‘was guided’

Nouns      *dérex* ‘way’, *madrix* ‘guide’, *darkon* ‘passport’,

*hadraxa* ‘guidance’, *midraxa* ‘sidewalk’.

Correspondingly, the phonological information provided by the nonvocalized Hebrew

orthography is essentially consonantal: all 22 Hebrew letters denote consonants. At the morphological level, all Hebrew letters participate in representing abstract root sequences (henceforth termed: *root letters*) in words. For example, *dérex* ‘way’ is spelled DRK, which is also the spelling of *darax* ‘stepped’; and the same root appears (underlined) in *hadraxa* ‘guidance’, spelled HDRKH, and in *midraxa* ‘sidewalk’, spelled MDRKH.

Root letters represent root consonants, which may sound different in different morphophonological environments, or sound similar to other consonants with other graphemic representations, but they are assigned a consistent spelling pattern, which preserves the unity of the root as a morpheme. Consider the spelling of the abstract root *d-r-k* ‘step’ which occurs in speech as *d-r-x* in *madrix* ‘guide’ and as *d-r-k* in *darkon* ‘passport’. The last segment in the root alternates in pronunciation (*k* spirantizes to *x*), but the root morpheme is represented consistently as DRK in both words: *madrix* is spelled MDRYK and *darkon* is spelled DRKWN. Root unity is thus preserved in two ways: (1) the spelling of the last segment (K) is the same for both oral representations (*k* / *x*); and (2) the root letter K designates the unique status of a deep phonological entity (spirantizing *k*, alternating with *x*) which sets it apart from two other phonetically similar forms: *k* (underlying *q*) represented by the letter Q, on the one hand, and *x* (underlying *h*) represented by the letter H, on the other.

A spelling error may occur within the root when one of the root consonants has two (and rarely, more) possible graphemic representations. For example, the words *katav* ‘wrote’, *któvet* ‘address’ and *mixtav* ‘letter’ contain root *k-t-v*, each of the root consonants having two possible graphemic representations: *k* can be represented by either K or Q; *t* can be represented by either T or T; and *v* can be represented by either B or W. The correct spelling is KTB. There is no a-priori reason for preferring one of the two options: In order to learn the correct spelling of the root, learners have to encounter it frequently enough and in as extended a word family as possible<sup>5</sup>. Given that there are about 1,800 roots in Modern Hebrew

(Choueka, 1996), this is quite a task.

*Function letters.* 11 of the 22 letters in the Hebrew alphabet (ANY ŠLMH KWTB, henceforth: *function letters*) consistently represent non-root constructs in addition to representing root elements. These function letters fall into two major groups: the group of *morphemic* function letters and the group of *attached* function letters.

Morphemic function letters designate non-root derivational and inflectional morphemes in patterns and in linear affixes. For example, Table 1 shows a number of functions designated by the morphemic function letter T (underlined) (for a full list of the functions of morphemic T, see Ravid, 1995:119-121).

Insert Table 1 about here

Attached function letters designate syntactic constructs, phrasal and clausal clitics (Spencer, 1991), which are written attached to the next word. Previous studies have shown that Hebrew readers are sensitive to the syntactic function of these letters (Koriat, Greenberg & Goldshmid, 1991), and that this sensitivity emerges early on (Zeidman, 2000). These letters fall into three subsets<sup>6</sup>:

- (1) Conjunctions    Coordinator *ve-* spelled W    Relative marker *she-* spelled Š
- (2) Definite article *ha-* ‘the’ spelled H
- (3) Prepositions    *me-* ‘from’ spelled M    *be-* ‘in’    spelled B  
                           *ke-* ‘as’    spelled K    *le-* ‘to’    spelled L

Of the 11 function letters, only four designate consonants nonambiguously: N, Š, L, and M. The rest are mapped onto homophonous letters. For example, the preposition *ke-* ‘as’ has two possible spellings: K and Q.

Learning to spell root letters and function letters relies on different cues. The large number of roots and the frequent occurrence of homophonous letters make learning to spell

roots correctly a long and arduous task which requires a large vocabulary and repetitious encounters with word-families sharing the same root. In contrast, learning to spell function letters is a simpler matter. The number of homophonous function letters is small (7), and each designates a fixed set of affixes. Given the small class of affixal morphemes, the small number of function letters, and their consistent mapping onto each other, my prediction is that the correct spelling of function letters will precede that of root letters, and that young spellers will succeed in spelling function letters earlier than root letters.

As a case in point, compare the spelling of the two letters designating the phoneme *t* - T and *T*. The current spelling difference reflects a historical distinction between the voiceless coronal stop T and the voiceless emphatic coronal stop *T*. Since they are both phonetically merged into *t* today, there is no way to know whether a root containing *t* should be spelled with T or *T* (e.g. *t-p-s* 'climb', spelled T-P-S versus *t-p-s* 'grasp', spelled T-P-S). Learning to spell a root with *t* depends on a variety of factors such as root frequency, the number of members of the word-family, and learners' familiarity with these members. By comparison, learning to spell non-root affixes with the same phoneme *t* (e.g., the plural feminine suffix *-ot* spelled -WT) is fairly easy: all affixes pronounced *t* are always spelled with T, never with *T*. Therefore, learning to spell roots *t* with will take much longer than learning to spell affixal *t*.

### **Testing the model**

The model of spelling development presented here takes into account phonological and morphological phenomena in the spoken language as well as how these features are represented in the orthography. It predicts children's path in becoming aware of these consistencies as reflected in their spelling errors. These considerations yield two general predictions: 1) Spelling grammatical words will be mastered earlier than content words; and 2) spelling function letters will be mastered earlier than root letters. Two studies were conducted to test these predictions. The first involved an analysis of spelling errors in

gradeschoolers' compositions; the second was a cross-sectional experiment designed to analyze spelling errors in gradeschool dictations.

### Study 1

The first study examined spelling errors in a natural sample of children's writing in gradeschool.

*Method and population.* 378 children participated in this study (187 boys, 191 girls), all native speakers of Hebrew from three schools in middle-class neighborhoods in a city in central Israel (Grade 1: N = 52; Grade 2: N = 30; Grade 3: N = 57; Grade 4: N = 70; Grade 5: N = 105; Grade 6: N = 64). This grade range was selected following a study by Eylon (1992), which showed that spelling errors frequently occur in the written productions of gradeschool children. Each child wrote a composition in class towards the end of the school year. Grade 1 pupils wrote about a character from their textbook or about their family. Children in grade 2 through 6 wrote about topics in science and technology such as computers and space travel, or about house pets and garden plants. Some wrote a story about a fight they had been involved in or expressed their opinion about violence in schools. These compositions were collected and analyzed immediately after being written. All the words in each composition were counted and classified into content words (nouns, verbs, adjectives, and manner adverbs) and grammatical words (pronouns, prepositions, conjunctions, quantifiers, etc.). Spelling errors were located and counted in both types of items. Spelling errors in content words were then classified into function letter errors and root letter errors.

### *Results.*

Prediction 1 stated that grammatical words would be spelled correctly earlier than content words. To test this prediction, two proportions were calculated: the proportion of erroneously spelled content words out of the total number of content words, and the proportion of erroneously spelled grammatical words out of the total number of grammatical

words. The calculating unit for this study was the *word*: even if two errors were made in the same word, they were calculated as one. The results are presented in Table 2.

Insert Table 2 about here

A two-way ANOVA (6 grades x 2 word error types: content word errors out of the total number of content words and grammatical word errors out of the total number of grammatical words) showed an effect for grade ( $F(5,363)=40.28, p<.001$ ), and for word error type ( $F(1,363)=42.01, p<.001$ ). An interaction was found between grade and word error type ( $F(5,363)=3.49, p<.004$ ), showing different learning curves: There is a drop in both types of errors, but content word errors remain high in grades 1 and 2 and drop steeply in higher grades, while spelling errors in grammatical words are scarce from grade 2 onwards. Prediction 1 was thus confirmed: Grammatical words are spelled correctly earlier than content words.

According to Prediction 2, spelling errors are dependent on morphological domain, so that spelling function letters is expected to be mastered earlier than the spelling of root letters. To test this hypothesis, the following analysis procedure was undertaken: The unit of analysis was the *letter*. In each composition, the number of homophonous root letters and function letters - those letters that had alternative spellings due to neutralized phonological distinctions - was counted. These constituted the total potential number for spelling errors. For example, the word *tikshoret* 'communication' is spelled TQŠWRT. In this word, there are 3 homophonous letters, each of which can be spelled in two ways: the letter T, which appears at the beginning and end of the word, and the letter Q. Both occurrences of T are function letters, while Q is a root letter. Thus, in this word there are 2 potential spelling errors in function letters, and one potential error in root letters. All in all there were 15,997 homophonous root letters in the children's compositions, and 6618 homophonous function letters.



In each composition, the number of actual errors in homophonous function and root letters was counted. All in all, there were 694 root letter errors and 91 function letter errors. The two following proportions were then calculated for each composition: the number of errors in function letters, out of all homophonous function letters; and the number of errors in root letters out of all homophonous root letters. Table 3 gives the means of these proportions per grade.

Insert Table 3 about here

To test prediction 2 a two-way ANOVA was performed (6 grades X 2 morphological types of letter errors: root vs. function). There was a significant effect of grade ( $F(5, 375)=31.08, p<.001$ ), showing the decline of actual spelling errors in homophonous letters with a potential for errors. There was an effect of morphological category ( $F(1, 375)=54.89, p<.001$ ), showing the difference between the proportion of spelling errors in root and function letters: there were almost three times as many root letters errors as function letter errors. There was also an interaction of grade and morphological category ( $F(5, 375)= 4.84, p<.001$ ), showing the different decline patterns in the spelling errors of the two morphological categories.

*Discussion.* Study 1 analyzed spelling errors in natural written production in grades 1-6. The two predictions of the model were confirmed in this study: 1) Grammatical words reveal a different developmental pattern than content words: Young children make more errors in content words than in grammatical words, and the number of errors in grammatical words remains low compared to that of content words even in 5<sup>th</sup> grade. 2) Function letters have a different developmental pattern than root letters: There is an essential difference between function letter errors, which almost disappear by second grade, and root letter errors, which decline gradually from third grade onwards.

One advantage of the method selected for Study 1 was that it allowed children to

select the topic of the composition and the specific words they wanted to use, thus removing the question of whether the young writer was familiar with the spelled words. Moreover, these authentic texts presented spelling errors in their natural context rather than in manipulated sentences. For example, we can observe the occurrence of root letter errors in three words derived from the same root *s-k-n* 'danger' such as *mesukan* 'dangerous', *siken* 'endangered' and *sakana* 'danger'. Finally, the proportion of content to grammatical words is again natural, in accordance with the content of the text, and makes it possible to observe the spelling of a variety of content and function categories. The need was felt, however, for a more structured design, which would focus directly on letters, which have a central role in this model. This design is described in Study 2 below.

## Study 2

The second study undertaken to test the model presented above was a cross-sectional experiment designed to analyze spelling errors made by gradeschoolers on a dictation test.

*Population.* The participants in this study were 72 native-Hebrew speaking gradeschoolers (42 boys and 30 girls) from 3 grades in a school situated in a middle-class neighborhood in the center of Israel: Grade 2: N = 25 (mean age: 7;3, age range: 6;8-8;2); Grade 3: N = 26 (mean age: 8;4, age range: 7;8-9;2); Grade 4: N = 21 (mean age: 9;3, age range: 8;9-10;0). The study focused on these three consecutive grades since Study 1 showed that the overwhelming majority of spelling errors occur in the middle section of school, and that the greatest leaps in spelling development take place between grades 2 and 4. Administering the test to grades 2, 3 and 4 permitted a closer look into the process of learning Hebrew spelling at the time when conceptualization of morphological units and their mapping onto alphabetical segments is under way (Ravid & Malenky, submitted).

*Materials and procedure.* The dictation test in Study 2 was administered to the study population in October, a month after school had started. It contained a total of 36 written

items selected after consultations with the class teachers to make sure they were familiar to the children. These consisted of 13 nouns, 19 verbs, one inflected preposition and 3 nominal phrases. All test items contained root and function letters, except the prepositions, which contained only function letters. For example, the verb *hitkarev* ‘approached’, spelled HTQRB, contains two function letters HT, signifying the *hitpa’el* verb pattern, and 3 root letters QRB. Seven of the test items had attached function letters. For example, the form *u-vi-r’otxa* ‘and-in-seeing-you = and upon your seeing’, spelled WBRAWTK, consists of the conjunction ‘and’ and the preposition ‘in’, attached to the infinitival form of the verb ‘see’, which is inflected for second person masculine singular. The test words are listed in Appendix 1. Since Hebrew has no frequency counts, the test items were given to 22 adult native speakers to rate for frequency. The mean frequency of the words was 4.00 on a scale of 1-5 (see Appendix 2). The test items were presented in sentences, and dictated to the whole class in 3 random orders using the following method: first the test item was read aloud, then the whole sentence, then the test item was read aloud again, and finally it was dictated to the class.

*Results.* The success score was based on the spelling of each letter. In preparation for analysis, all the letters in the test items were counted and classified into sets. The first classification was into root and function letters. There was a total of 108 root letters. Of these, 57 letters were homophonous, with 2 (in rare cases, 3) spellings. For example, the root *l-b-b* ‘heart’ appearing in the word *levavxa* ‘your heart’ is spelled LBB, with another potential spelling LWW.

The total number of function letters was 77. Of these, 52 were homophonous, with 2 (in rare cases, 3) potential spellings. For example, the second person suffix *-xa* on test items such as *kamóxa* ‘like you,Sg,Masc’ is spelled with a final K, and another potential spelling is H. There were no other spelling errors in the subjects’ dictations apart from misspellings of

homophonous letters. To test prediction 2 (spelling of function letters would precede that of root letters) two proportions were calculated: the number of spelling errors in function letters out of the number of potential errors, i.e., the number of homophonous function letters; and the number of spelling errors in root letters out of the number of homophonous root letters.

Insert Table 4 about here

Prediction 2 was confirmed in this study as well. Table 4 presents the mean percentages of spelling errors in root letters out of all homophonous root letters, and the mean percentages of spelling errors in function letters out of all homophonous function letters. A two-way ANOVA of grade (3) X letter type (2: root vs. function) showed an effect for grade ( $F(2,44) = 20.41, p < 0.001$ ) and for letter type ( $F(1,44) = 25.83, p < 0.001$ ). Both types of spelling errors decline with age, but root letter errors exceed function letter errors in all grades, and by grade 4, there are 3 times as many root letter errors than function letter errors.

*Word frequency and spelling errors.* A model that assumes a tight relationship between word frequency and number of spelling errors will predict a strong negative correlation between them: the lower the word frequency, the higher the number of spelling errors in that word. A model that assumes that number of spelling errors is affected by both frequency and morphological factors will predict a weak or no correlation. In order to find out the relationship between word frequency and number of spelling errors, the following procedure was undertaken: For each word, the number of spelling errors (root plus function letter errors) was calculated as a percentage out of the total potential number of errors (homophonous letters with 2 possible spellings) for that word. For example, the word *tahaluxa* 'parade' spelled THLWKH had a total of 4 potential errors: 2 potential function letter errors (initial T and final H), and 2 potential root letter errors (H and K). A Pearson test was conducted to find out the correlation between percentage of spelling errors in each word and its frequency grade on a 1-5 scale (see Appendix 2), for the whole population and for

each grade separately. For the entire population, the Pearson correlation test yielded the result of  $r = -.07$ ,  $p < .001$  ( $N=2,685$ ). The correlations found for the three grades separately were  $r = -.08$ ,  $p < .02$  ( $N=932$ ), for grade 2;  $r = -.06$ ,  $p = .059$  ( $N=943$ ) (no significant correlation), for grade 3; and  $r = -.10$ ,  $p < .004$ , ( $N=810$ ) for grade 4. Thus a very weak negative correlation was found between percentage of spelling errors and word frequency, confirming the hypothesis put forth in this paper concerning the joint effect of morphology and frequency on developmental processes of Hebrew spelling.

*Discussion.* Study 2 focused on the second prediction of the model proposed in this paper, namely, that function letters would be spelled correctly earlier than root letters. While Study 1 used naturalistic data analyzed for error types, Study 2 was an experimental design in which gradeschoolers were given a dictation containing test items with homophonous root letters and function letters. A comparison of the number of spelling errors in these two morphological classes shows the same pattern as Study 1 and supports the prediction for earlier acquisition of function letters over root letters. Moreover, a very weak correlation was found between the frequency rating for each word and spelling errors on each word, summed across letters. This means that word frequency is not a major factor predicting how many spelling errors will be made in words with homophonous letters. As a case in point, consider the spelling of the highly synthetic word *u-vi-r'otxa* 'and-in-your-seeing', spelled WBRAWTK, which has the lowest frequency rating on the list (1.86 on a scale of 5, Appendix 2). Despite the rarity of the word and the fact that almost all of its letters (6 out of 7) are homophonous, the overwhelming majority of these letters (WBWTK) are uniquely and transparently mapped function elements: W = coordinator 'and'; B = preposition 'in'; WT = infinitival marker of *y-*final roots; and K = possessive marker of 2<sup>nd</sup> person singular. The whole word may be relatively rare, but the elements it consists of belong to a small, easily identifiable, and frequently encountered set. Thus, errors in children's Hebrew spelling are motivated at least

to some extent by morphological considerations.

### **General discussion**

This paper presented the hypothesis that growth in spelling acquisition, like growth in oral language acquisition, is subject to typological constraints. Morphological complexity in the oral language mode is mirrored, to a certain extent, in its written mode. Hence, a model which claims to account for spelling development should be able to show how children become aware of different morphological constructs in the orthography of their language, to make specific predictions about their order of appearance, and to provide an explanation of this route in linguistic and cognitive terms. In this paper, I have attempted to formulate and test such a model for Hebrew and have argued for the need for differential kinds of knowledge and representations necessary for learning how to spell in a morphologically rich language.

Two predictions followed from the hypothesis of the interface of phonology and morphology in spelling acquisition: 1) Grammatical words will be spelled correctly earlier than content words; and 2) function letters will be spelled correctly earlier than root letters. Both predictions were confirmed in the studies described above.

Both predictions were confirmed. At the word level, study 1 indicates that the occurrence of spelling errors is determined by the class of words in which they appear (content words vs. grammatical words). Content words are spelled correctly later than grammatical words for a number of reasons: the former have a low type frequency, while their token frequency varies according to register and genre. This means that there is a lower chance of encountering them in print and work out a systematic analysis of their spelling to begin with, depending on the topic and the context. Grammatical words, a small, closed class

occurring obligatorily in any kind of text, have a low type and high token frequency. This makes for numerous occurrences of the same word, which are thus likely to create deep memory traces in spellers early on. Moreover, content words are longer and more likely to contain roots whose spelling is unpredictable, while grammatical words are usually shorter and often fused with function suffixes (e.g., *kamó-xa* ‘like-you’) whose spelling is predictable.

The earlier emergence of correct spelling in content words than in grammatical words is not restricted to Hebrew. The difference in type / token frequency, in word length, and in internal morphological structure between open-class and closed-class words is found in many languages. The confirmation of Prediction 1 is not language-specific. In addition, it is not only morphology that accounts for these results: frequency and consistency played a role alongside morphology in explaining why grammatical words are spelled earlier than content words. At the letter level, both studies indicate that morphological class determines which letter type will be spelled earlier. According to Study 1, root letters continue to constitute the main spelling challenge to children up to grade 6, where spelling errors of both types are restricted to a few pupils. In contrast, errors in function letters as a whole constitute less than 1/7 of the spelling errors in root letters in the children’s compositions. According to Study 2, by Grade 4 the number of function letter errors is a third of the number of root letter errors. Some potential spelling errors in function words, such as marking the feminine suffix *-a* other than with H, or spelling the conjunction ‘and’ by B instead of W, simply do not occur after Grade 1. This is due to the combination of high token frequency and unique marking: Suffixal *-a*, for example, is the most common singular feminine marker in Hebrew, acquired early on in speech (Kaplan, 1983; Levy, 1980), and whose spelling is already familiar to many kindergartners (Levin & Korat, 1993; Levin et al., 1997). Its salient site in a stressed syllable at the end of the word facilitates mapping semantics onto a unique spelling pattern.

The confirmation of Prediction 1 is Hebrew-specific. Morphology plays a crucial role in determining which letter type would be learnt first. Because of the wealth of morphological options in spoken Hebrew, Hebrew-speaking children look for morphological cues in their orthography, and make efficient use of them in learning to spell. Hebrew-speaking children know about roots and affixes in their spoken language from early on (Ravid, in press). Therefore, it is natural for them to turn to a morphological strategy when they are learning to spell. There is accumulating evidence that children learning a morphologically sparse language with a shallower orthography such as Dutch do not make as much use of morphological cues in learning to spell (Gillis & Ravid, in press).

Emergent morphological strategies are not restricted to Hebrew, however. Byrne (1996) found that even preliterate children do not select only phonologically-based hypotheses about how print represents speech, but instead focus on morpho-phonologically and/or semantic aspects of words referents. Treiman and her colleagues have shown in a series of studies (Treiman & Cassar, 1996; Treiman, Cassar & Zukowski, 1994; Treiman, Zukowski & Richmond-Welty, 1995) that English-speaking kindergartners and first graders were guided to some extent by morphological information in their spelling. Their spellings of flapped *t* and *d* and of first liquid and nasal Cs in final consonant clusters indicated some awareness of internal morphological structure in mono- and bi-morphemic words. Thus even young children learning English supplement their phonological spelling strategies with initial morpheme-to-grapheme mapping attempts.

#### Learning to spell in gradeschool

Transparency, consistency and frequency contribute to learning Hebrew spelling and especially to making the spelling of function letters a precocious acquisition by the end of second grade. By kindergarten, Israeli children know much about their spoken morphology, and especially about inflectional morphology (Ravid, 1995). Previous studies on the



development of written language show that children start to apply knowledge on spoken morphology to writing in kindergarten, and that knowledge about the spelling of function letters consolidates in first grade (Levin et al., 1999; Levin & Korat, 1993; Sandbank, 1992). Later on, by 4th grade, young spellers are already on the way to learning to spell roots. A number of factors coalesce at this time to promote a drastic change in spelling knowledge. One factor is cognitive, predicted by the well-known Piagetian developmental model (Piaget & Inhelder, 1968). Another factor is the consolidation of literacy: by third grade Hebrew-speaking children have been introduced to a variety of texts from different genres and registers, including Biblical texts, enabling them to move into a phase of automatization of reading and writing, on the one hand, and to demonstrate increasingly explicit awareness of salient and frequently occurring morphological structures in Hebrew, on the other. A third factor is linguistic in nature: studies of late-emerging systems - complex linguistic systems which require the integration of several linguistic resources, such as deverbal nominals - indicate the onset of acquisition around 8-9 years of age (Berman, 1985; Ravid & Avidor, 1998). Catching up with the spelling of root letters attests to the consolidation of morphological knowledge in gradeschoolers and to the expansion and diversification of a literate lexicon based on the written language (Anglin, 1993).

#### Educational issues

This study shows that two functional systems - lexical and grammatical - though encoded in the same orthographic symbols, are acquired at different rates because they present different challenges to gradeschoolers. One implication of this work is that content words in general, and root letters, in particular, require a longer period of exposure to a wide variety of words and root-based word-families in different kinds of texts than grammatical words and function letters. This is one more argument for the importance of multifaceted exposure of schoolage children to a variety of authentic texts in which words appear in

natural contexts, illustrating their different uses and meanings and highlighting the subtle differences between words of the same root-based family: Compare, for example, *kibuts* ‘kibbutz’, *kvutsa* ‘group’, *kóvets* ‘file, article collection’, and *kabtsan* ‘beggar’, all derived from root *q-b-c* ‘gather’, spelled QBC. Another educational implication is the need for gradeschool teachers to gain more understanding of the nature of the linguistic systems underlying the orthographic system of Hebrew, which motivates spelling acquisition. Previous work indicates that such knowledge in gradeschool teachers is insufficient (Strauss, Ravid, Zelcer & Berliner, 1999).

### Conclusion

This paper has attempted to show that language typology, an important factor in accounting for the development of spoken language, plays a critical role in learning to spell in Hebrew. The distinction between roots and affixes is basic to Semitic language word-formation, and shows up early on in Hebrew-speaking children’s perception of spoken morphology (Berman, 1995). This distinction has been shown to motivate Israeli children’s route in learning to spell content words and grammatical words, and roots versus affixes in content words. Gradeschool children’s spelling shows that they are aware of semantic and grammatical information expressed in spelling distinctions: they know that morphosyntactic aspects of language that are not marked at the phonological level are nevertheless orthographically represented in function letters.

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<b>Grade</b>	<b>Proportion # spelling errors in content words / # content words</b>		<b>Proportion # spelling errors in grammatical words / # grammatical words</b>	
	<b>Means</b>	<b>SD</b>	<b>Means</b>	<b>SD</b>
G1	28.79	27.64	19.04	22.74
G2	20.21	16.05	7.66	9.86
G3	9.32	11.21	5.91	13.12
G4	6.60	7.56	3.45	6.75
G5	6.30	6.89	2.65	4.98
G6	3.43	4.18	2.20	3.67

Table 2: Number of erroneously spelled content words / number of content words, and number of erroneously spelled grammatical words / number of grammatical words per composition

<b>Grade</b>	<b>% Root letter errors</b>		<b>% Function letter errors</b>	
	<b>Means</b>	<b>SD</b>	<b>Means</b>	<b>SD</b>
<b>Grade 1</b>	20.26	23.60	14.53	26.04
<b>Grade 2</b>	16.38	13.92	2.21	4.87
<b>Grade 3</b>	6.75	10.86	.99	4.69
<b>Grade 4</b>	4.29	6.38	.58	2.26
<b>Grade 5</b>	3.70	5.69	.92	2.80
<b>Grade 6</b>	1.21	2.41	.69	2.12
<b>Total</b>	7.19	13.00	2.86	11.23

Table 3: The mean percentage of root letter errors, out of all homophonous root letters; and the mean percentage of function letter errors, out of all homophonous function letters in Study 1, by grade

<b>Grade</b>	<b>% Root letter errors</b>		<b>% Function letter errors</b>	
	<b>Mean</b>	<b>SD</b>	<b>Mean</b>	<b>SD</b>
Grade 2	21.02	9.99	15.61	8.27
Grade 3	8.18	8.06	5.10	5.64
Grade 4	6.41	6.41	1.69	3.29
Total	11.29	10.39	6.85	8.24

Table 4: The mean percentage of root letter errors, out of all homophonous root letters; and the mean percentage of function letter errors, out of all homophonous function letters in Study 2, by grade

## Appendix 1: The spelling test of Study 2.

Information is given on the spoken form of the word, its gloss, and a transcription of the Hebrew written graphemes into English capital letters alongside with the original Hebrew spelling

<b><u>Spoken word</u></b>	<b><u>Gloss</u></b>	<b><u>Written transcription</u></b>
<i>akashkesh</i>	I will scribble	אקשקש AQŠQŠ
<i>ha-kélev</i>	the-dog	הכלב HKLB
<i>u-vi-r'otxa</i>	and-in-your-seeing	ובראותך WBRAWTK
<i>hana'a</i>	enjoyment	הנאה HNAH
<i>em ve-tinok</i>	mother and-baby	אם ותינוק AM WTYNWQ
<i>yevakesh</i>	will ask	יבקש YBQŠ
<i>tetalpen</i>	you will-telephone, Sg, Masc	תטלפן TTLPN
<i>haláxta</i>	you walked, Sg, Masc	הלכת HLKT
<i>levavxa</i>	heart-yours, Sg, Masc	לבבך LBBK
<i>1.beráxti</i>	I blessed	ברכתי BRKTY
<i>1.xanuyot</i>	shops	חנויות HNWYWT
<i>2.tardema</i>	sleep	תרדמה TRDMH
<i>3.u-xshe-ba</i>	and-when-(he/it) came	וכשבא WKŠBA
<i>4.hit'ahev</i>	fell in love	התאהב HTAHB
<i>5.tsaláxat</i>	plate	צלחת CLHT
<i>5.kamóxa</i>	like-you, Sg, Masc	כמוך KMWK
<i>7.sakit</i>	plastic / paper bag	שקית ŠQYT
<i>3.rakévet</i>	train	רכבת RKBT
<i>3.hisbir</i>	explained	הסביר HSBYR

1. <i>histaper</i>	got a haircut	הסתפר HSTPR
1. <i>ozéret</i>	cleaning lady	עוזרת 9WZRT
2. <i>malkat ha-kita</i>	class queen (most popular girl)	מלכת הכיתה MLKT HKYTH
3. <i>hana 'a</i>	moving	הנעה HN9H
4. <i>tafkid</i>	role / part	תפקיד TPKYD
5. <i>huxlat</i>	was decided	הוחלט HWHLT
5. <i>tesaper</i>	will tell.	תספר TSPR
7. <i>tahaluxa</i>	parade	תהלוכה THLWKA
3. <i>hutkaf</i>	was attacked	הותקף HWTQP
2. <i>hitkarev</i>	approached	התקרב HTQRB
2. <i>u-ve-kumxa</i>	and-in-your-rising	ובקומך WBQWMK
1. <i>amárti</i>	I said	אמרתי AMRTY
2. <i>hevin</i>	understood	הבין HBYN
3. <i>shaxáta</i>	you forgot, Sg, Masc	שכחת ŠKHT
4. <i>mixnasáyim u-smalot</i>	pants and dresses	מכנסיים ושמלות MKNSYYM WŠMLWT
5. <i>yexatel</i>	will-diaper	יהתל YHTL
5. <i>xatula</i>	cat, Fm	חתולה HTWLH



Appendix 2: Frequency rating of the test items in Study 2 by 22 judges (0.87 agreement) on a scale of 1-5 (1 least frequent, 5 most frequent).

<u>Test Item</u>	<u>Mean Frequency</u>
<i>amárti</i>	4.93
<i>shaxáxta</i>	4.90
<i>histaper</i>	4.86
<i>sakit</i>	4.86
<i>hitkarev</i>	4.84
<i>xatula</i>	4.82
<i>ozéret</i>	4.82
<i>hevin</i>	4.80
<i>ha-kélev</i>	4.82
א. <i>haláxta</i>	4.73
א. <i>tesaper</i>	4.73
ב. <i>xanuyot</i>	4.73
ג. <i>mixnasáyim u-smalot</i>	4.73
ד. <i>rakévet</i>	4.73
ה. <i>tsaláxat</i>	4.73
ו. <i>hisbir</i>	4.68
ז. <i>malkat ha-kita</i>	4.64
ח. <i>kamóxa</i>	4.55
ט. <i>tafkid</i>	4.50
י. <i>yevakesh</i>	4.41
יא. <i>tetalpen</i>	4.23

2. <i>hitahev</i>	4.23
3. <i>huxlat</i>	4.11
4. <i>em ve-tinok</i>	3.86
5. <i>u-xshe-ba</i>	3.50
5. <i>hana'a</i> ‘pleasure’	3.27
7. <i>tahaluxa</i>	3.22
3. <i>beráxti</i>	3.18
3. <i>hutkaf</i>	3.11
3. <i>yexatel</i>	3.03
1. <i>akashkesh</i>	2.46
2. <i>hana'a</i> ‘motivation/	2.32
3. <i>levavxa</i>	2.32
4. <i>tardema</i>	2.14
5. <i>u-ve-kumxa</i>	1.89
5. <i>u-vi-r’otxa</i>	1.86
<b><i>Mean frequency</i></b>	<b>3.99</b>

Out of the 36 test items, 25 were ranked 3.5 mean frequency and above; 9 were ranked under 3.5. 64% of the function letters and 72% of the root letters respectively appeared in frequent test items (“frequent” defined as mean frequency 3.50 and above). 36% of the function letters and 28% of the root letters, respectively, appeared in less frequent items, under 3.50. The homophonous function letters that appear in the less frequent words all also appear in the frequent words, e.g., feminine marker *-a* spelled H, second person marker *-xa* spelled K, pattern prefixes *h-* (spelled H) and *t-* (spelled T). All homophonous root letters that appear in the less frequent words (e.g., *v*, *t*, *x*) also appear in the frequent words.

## Notes

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<sup>1</sup> The following conventions are used: Capitals for spelling, italics for general and oral language examples.

<sup>2</sup> For reasons of convenience, the following symbols were chosen to designate the following Hebrew letters: *ṭ* (the historical emphatic coronal) is represented in this paper as italicized *T*, as distinct from *ṭ*, represented by *T*; *ḥ* (the voiceless pharyngeal fricative) is represented by italicized *H*, as distinct from *ḥ* *K*; *ʕ* (the voiceless coronal affricate) is represented by *C*; and the digit 9 represents the letter *ʕ* (voiced pharyngeal fricative).

<sup>3</sup> *Cs* indicate sites of root consonants in the word.

<sup>4</sup> The term ‘grammatical word’ was selected to refer here to what is usually known as ‘function words’ in order not to confuse them with ‘function letters’.

<sup>5</sup> For example, in the case of *KTB*, this is a lexically “rich” root that occurs in numerous, quite familiar words, e.g., in the verbs *katav* ‘wrote’, *nixtav* ‘was written’, *hixtiv* ‘dictated’, *hitkatev* ‘corresponded’; in the adjective *katuv* ‘written’; and in the nouns *mixtav* ‘letter’, *ktav* ‘writing’, *ktiv* ‘spelling’, *taxtiv* ‘formal dictation’, *któvet* ‘address’, *katav* ‘reporter’, *haxtava* ‘dictation’, *ktuba* ‘marriage contract’.

<sup>6</sup> The link between attached function letters and the next word is not only orthographic: all of them, except for *she-* ‘that’, spelled *š*, have morphophonological allomorphs depending on their environment (e.g., *ve-* ‘and’ also has the forms *vi-* and *u-*). The spelling (e.g., *W*) does not change since the difference is in the accompanying vowel which is not represented in non-vocalized spelling. Mastery of all possible allomorphs is part of literate language knowledge in Hebrew (Ravid, 1996).