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Morphology and spelling among Hebrew-speaking children: from kindergarten to first grade*

IRIS LEVIN
School of Education, Tel Aviv University

DORIT RAVID
School of Education and Department of Communications Disorders, Tel Aviv University

SHARON RAPAPORT
Department of Communications Disorders, Tel Aviv University

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ABSTRACT

This study had two major objectives: (1) to analyse the development of two morphological structures in Hebrew, one inflectional and the other derivational and (2) to examine the mutual contribution of morphological knowledge and learning the written code. In a longitudinal design, 40 children were tested twice, first in kindergarten (mean age: 5; 11) and again in first grade (mean age: 6;5), on two oral tasks – inflecting nouns for possession and deriving denominal adjectives – and one written task of writing a series of noun-adjective pairs. The derivational task was found to be harder than the inflectional task, both on the stem and the suffix level, attributable to its higher semantic opacity. In both oral tests, correct stem production when suffixed was related to the morphophonological level of stem change. Correlations were found between morphological and writing scores. Moreover, children who were more advanced in morphology in kindergarten progressed more in writing vowels from kindergarten to first grade, and those who were more advanced in writing in kindergarten improved more in derivational morphology with grade.

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e-mail: irisl@post.tau.ac.il

INTRODUCTION

This study is grounded in an approach that views written language as a conceptual model of oral language, rather than a transcription of it. When children encounter print and storybooks, and later on when they learn to read and write, they come to grasp their spoken language from without, to analyse it and reflect on it in a manner shaped by written language categories. According to this approach elaborated by Olson (1994), written language defines the linguistic categories that will be brought into consciousness, and different scripts shape speakers' perception of language differently. Thus becoming literate, in the double sense of learning both the written code and how to use it in written discourse, moulds and promotes the child's understanding of the spoken language. Concomitantly, it has been argued that linguistic and metalinguistic competencies provide a foundation for the acquisition of literacy. However, the empirical evidence for such a causal link is rather equivocal (e.g. Reeder, Shapiro, Watson & Goelman, 1996).

Our study attempts to establish a specific connection between language and literacy. We propose a bootstrapping model of learning to use the written code, on the one hand, and the development of the oral morphology typical of the written register, on the other. According to this model, learning to write promotes and shapes oral literate morphology, while sensitivity to oral morphology enhances the acquisition of writing. A similar model has already gained support in the literature with respect to phonological awareness and reading (Stahl & Murray, 1998; Goswami, 1999). The young child's level of phonological awareness has been found to correlate with the pace of learning to read, and learning to read, in turn, has been shown to promote phonological awareness. Moreover, phonological awareness is shaped by the particular writing system the child is exposed to, as shown by Tolchinsky & Teberosky (1998), who compared word segmentation in Hebrew and Spanish; by Gillis & de Schutter (1996) in regard to the segmentation of words with orthographic geminates in Dutch; and by Treiman (1985), Ehri & Wilce (1986) and Treiman (1993), who showed that children's phoneme judgments, of say flaps, e.g. the middle sound in 'city', became adult-like with learning their spelling.

However, alphabetical orthographies do not only represent phonological constructs; they also reflect morphological units. For example, in English the adjectival suffix *-ic* has three different phonetic values in *electric* [k], *electrician* [sh] and *electricity* [s], yet is consistently spelled with the same letter C, reflecting its morphological unity. Children may be expected to become aware of such morphological consistencies in their writing system and re-conceptualize their perception of spoken constructs accordingly.

Carlisle (1996) used morphological categories to study spelling improvement in spontaneous story writing in 2nd and 3rd graders and found that spelling was morphologically dependent, with some categories mastered earlier than others. In a longitudinal study, Nunes, Bryant & Bindman (1997) described a developmental model of -ED spellings: gradeschool children are at first unaware of the grammatical function of the *-t* and *-d* past-tense suffixes, and then extend them to other categories, including nonverbs. Later they restrict these suffixes to verbs but generalize them to irregular verbs as well, and finally they apply conventional -ED spelling only where appropriate. A series of studies in French showed a developmental sequence in the manner in which gradeschool children learn to mark plural number on nouns and verbs in writing, marks that are not reflected in the pronunciation (Largy, Fayol & Lemaire, 1996; Totereau, Theverin & Fayol, 1997). Aidinis & Nunes (1997) found a similar sequence of development in a study of Greek-speaking children in grades 2–5. Derwing, Smith & Wiebe (1995) showed that adult spellers use orthographic knowledge in English to analyze morphological structures.

Our study focuses on the interrelationship between the development of morphological knowledge in Hebrew and early word writing.

Hebrew morphology and spelling

Hebrew seems particularly appropriate for examining such interrelations because it is a synthetic language with a wealth of morphological structures. Word structure in Hebrew takes two main forms, non-linear and linear. The first refers to the classic Semitic root-and-pattern morphology, which combines two separate, discontinuous tiers: a consonantal tri- or quadrilateral skeleton mapped onto a vocalic pattern. Together they create a prosodic CV template which is the basic tier of representation in Semitic nonlinear structures (McCarthy, 1982). For example, note the root *s-x-k* 'play' in Table 1.

TABLE 1. *Root and pattern morphology in Hebrew*

Word meaning	Gloss	Pattern form	Pattern meaning
saxak	grinned	*CaCaC*	Verbal pattern P1*
sixek	played	*CiCeC*	Verbal pattern P3*
misxak	game	*miCCaC*	Abstract nominal
saxkan	player, actor	*CaCCan*	Agent noun

* There are seven patterns in Hebrew, termed *binyanim*, literally 'buildings'. Basic P1 is traditionally known as Qal, and P3 as Pi'el.

TABLE 2. *Stem and suffix morphology in Hebrew*

	Gloss	Stem and Derivational suffix	Stem and Suffix meaning
Derived noun			
xidon	charade	*xida-on*	riddle-collective
taklitan	disc jockey	*taklit-an*	record-agent
sakit	small bag	*sak-it*	sack-diminutive
ma'afiya	bakery	*ma'afe-iya*	baked product-place
mal'axi	angelic	*mal'ax-i*	angel-Adj
burut	ignorance	*bur-ut*	ignorant-abstract
Inflected noun			
para	cow	*par-a*	bull-Fm
kadim	jars	*kad-im*	jar-Pl
kosot	glasses	*kos-ot*	glass-Pl, Fm
sodo	his secret	*sod-o*	secret-his

The root and pattern are interdigitated, so that pattern vowels follow root consonants at different sites. For example, *misxak* 'game' starts with a pattern prefix *mi-*, followed by the first two root consonants *sx*, then the pattern vowel *a* and finally the third root consonant *k*.

Non-linear morphology is essentially derivational in Hebrew, and is found in all lexical classes. All verbs, most nouns and adjectives, and some adverbs, are constructed by the nonlinear affixation of root and pattern (Bolozky, 1997), with about 1800 roots and 50 patterns creating the majority of the lexicon (Choueka, 1996). However, this is by no means the only word structure found in Hebrew. Alongside non-linear constructions, Hebrew contains linear structures akin to those found in English *book-s*, *agree-ment*, with a stem concatenated to a suffix, e.g. *kamut-i* 'quantitative' from *kamut* 'quantity' suffixed by denominal adjectival *-i*. These linear structures constitute one of the foci of our study.

Unlike nonlinear structures, linear stem-and-suffix forms are widely found in both inflectional and derivational domains. The morphological role and impact of linear structures is central in nominal (noun and adjective) forms which take a wide variety of derivational and inflectional suffixes. These modify the noun stem grammatically – by gender, number or person – and lexically – by assigning it a variety of categories such as agent, instrument, place, diminutive, abstract nominal, etc. Table 2 illustrates these possibilities with a selection of derivational and inflectional suffixes.

Hebrew spelling reflects its morphological infrastructure. About a third of the phonemes can be represented by two graphemes (or rarely more). For instance the phoneme /s/ can be spelled with the letters S (SAMEX) or SH (SIN), the phoneme /x/ with X (XET) or K (KAF), and /k/ with Q (KUF) or K (KAF), (KAF can thus stand for two phonemes, a stop and a spirant).

Lexical entries derived from the same root, such as *saxak* 'grinned', *sixek* 'played', *misxak* 'game', *saxkan* 'actor' (see Table 1), are spelled as a rule with the same root letters, here SH X Q. Consequently, becoming aware, either implicitly or explicitly, of a root shared by a group of words, and knowing how any one of them is spelled, provides a powerful clue to the spelling of all. Similarly, learning the spelling of these words contributes to a grasp of the root connection between them.

By the same token, words which share a stem (see Table 2), such as *kos* 'glass', *kosit* (dim.) 'small glass', *kosot* (pl.) 'glasses', *kosi* (poss.) 'my-glass', are also regularly spelled with the same stem letters, here (K) KAF, (W) WAW, (S) SAMEX. Moreover, suffixes (see Table 2), like the diminutive *it* in *kap-it* 'teaspoon' and *kos-it* 'small glass', are spelled alike, here for example, with T (TAF). Finally, words which obey the same pattern, such as *tikshóret* 'communication', *tikbólet* 'parallelism', and *tishlóvet* 'combination', all examples of the noun pattern *tiCCóCet*, share the same pattern letters, here T (TAF) as the first and last letters. (Stress, which is usually word-final, is marked here only when non-final.) Consequently, morphological awareness and knowledge of roots, stems, affixes and patterns should promote spelling, while knowing how to spell should enhance understanding of the morphological infrastructure of the language.

This study investigated the relationship between learning two linear oral structures in Hebrew and writing words. One difference between English and Hebrew linear word-formation is the fact that the former employs stems which may or may not be words, e.g. *dign-ity*, *ident-ical*, while in Hebrew the overwhelming majority of stems are themselves words. Like English, however, Hebrew linear stems may either remain unchanged, as in *deep/deepen*, or undergo morphophonological changes as in *deep/depth*. The perception of morphophonologically changing stems has itself been shown to be related to literacy skills. Jones (1991) tested first graders on the segmentation of morphophonologically complex and simplex forms in English, and found that children with a better ability in reading, writing and metalinguistic awareness were more sensitive to the phonological and semantic relationships between derived forms and their stems. Fowler & Liberman (1995) tested gradeschool children aged seven to nine years of age on production of morphophonologically complex and simplex forms with derivational suffixes (*four/fourth*, *five/fifth*), and found a strong relationship between reading level and the ability to extract phonologically complex stems.

Stem changes in Hebrew can be classified into five basic forms (Ravid, 1995): (1) vowel deletion, (2) vowel change, (3) stop/spirant alternation, (4) *t*-alternation, and (5) complex stem change. Stress in Hebrew is either ultimate (on the final syllable) or penultimate (before the final syllable). Stem changes go hand in hand with a shift in stress from the stem to the suffix.

TABLE 3. *Stem changes in suffixed inflections and derivations in Hebrew*

Linear form	Gloss	Stem and suffix	Type of stem change
		Inflections	
0. *tanurim*	ovens	*tanur-im* oven-Pl	*No change*
1. *ozni*	my nose	*ózen-i* nose-my	*Vowel deletion*
2. *kalato*	his bride	*kala-o* bride-his	*t-alternation*
3. *apim*	noses	*af-im* nose-PL	*Stop/spirant alternation*
4. *aduma*	red	*adom-a* red-Fm	*Vowel change*
Complex changes			
5. *nashim*	women	*isha-im* women-Pl	*Idiosyncratic change*
6. *sifra*	her-book	*séfer-a* book-her	Vowel change +vowel deletion
7. *malka*	queen	*mélex-a* king-Fm	Stop/spirant +vowel change +vowel deletion
		Derivations	
0. *shiron*	song-book	*shir-on* song-collective	*No change*
1. *xofshit*	free	*xófesh-it* freedom-AdjFm	*Vowel deletion*
2. *nekudati*	specific	*nekuda-i* point-Adj	*t alternation*
3. *rakut*	softness	*rax-ut* soft-abstract	*Stop/spirant alternation*
4. *xuki*	legal	*xok-i* law-Adj	*Vowel change*
Complex changes			
5. *simlit*	symbolic	*sémel-it* symbol-AdjFm	Vowel change +vowel deletion
6. *harari*	mountainous	*har-i* mountain-Adj	Surfacing historical double root
7. *dubon*	little-bear	*dov-on* bear-diminutive	Stop/spirant +vowel change

These changes are systematically incurred by stem type and gender, as shown below.

(1) *Vowel deletion* (especially *a*-deletion) in word-internal open syllables, with concomitant re-syllabification, is the most common change in nominal stems, e.g. *davar/dvar-im* 'thing/things'. (2) *Vowel change* occurs mainly in stems with underlying or historical 'double' roots, i.e., roots with identical second and third radicals, e.g. *m-s-s* as the underlying root of *mas/mis-av* 'tax/his taxes'. (3) *Stop/spirant alternation* of *bkp/vxf* obstruents in stem-

final position (Ravid, 1995) again mainly expresses the underlying 'double' root, e.g. *kaf/kap-it* 'spoon/teaspoon', from the root *k-p-p*. (4) *Alternation of t* occurs in two directions. A suffixal *-t* is inserted in bound feminine nominal stems ending in stressed *-a*, e.g. *sira/sirat-o* 'boat/boat-his = his boat'. (Historically, these forms ended in *-at*, and the underlying *-t* surfaces as a result of a re-syllabification process when the suffix is attached to the stem.) A stem-final non-root *-t* may be deleted in bound stems, e.g. *xanut/xanuy-ot* 'shop/shops'. (5) In many cases, stem changes occur in clusters and result in a *complex change*. For example, *dov/dubon* 'bear/little bear'; *kélev/klav-im/kalb-a* 'dog/dogs/bitch'; *har/harari* 'mountain/mountainous'. Cases of no-change, the four basic forms of change, and change conjunctions, are illustrated by both inflection and derivation in Table 3.

It is important to note here that the semantics of linear suffixes differs greatly in inflections vs. derivations. Inflectional suffixes, e.g. possessive *-o* (*kalato* 'his bride'), do not change the lexical category of the word, apply across the board in relevant sites, and are predictable and semantically transparent. In contrast, derivational suffixes indicate a range of morphological classes, for example, adjective (*xofshi* 'free' derived from *xófesh* 'freedom'), instrument (*mitriya*, 'umbrella' derived from *matar* 'rain'), place (*iriya* 'municipality', from *ir* 'city'). Such words may change lexical category, are semantically and structurally unpredictable, and the rules forming them are neither obligatory nor generally applicable (cf. Bybee, 1985).

Despite the semantic difference involved, all nominal stems undergoing linear suffixation display similar stem changes when either inflectional or derivational suffixes are added (see Table 3), and some even formally identical suffixes are involved. For instance, the stem *báyit* yields *beyti* as either the inflected form 'my home' (poss.) or the derived form 'domestic' (denominal adj).

The oral morphological aspect of our study focuses on two nominal constructions that undergo linear suffixation with and without stem change. One is inflectional, the formation of possessive-marked nouns, and the second derivational, creating *i*-suffixed denominal adjectives. Both structures are late acquisitions of gradeschoolers (Berman, 1985,1995; Ravid & Nir, 2000).

Possessive (*genitive*) *marking on nouns*. (See inflection examples 1, 2, 6, in Table 3.) Inflection is represented in this study by morphological markers of possession on nouns. For historical reasons, Hebrew allows speakers to mark possession on nouns either syntactically or morphologically. The more transparent syntactic option of designating possession by a separate preposition, *shel* 'of' (e.g. *ha-gil shel-o* 'the-age of-him = his age'), is acquired early on (Berman, 1985) and is characteristic of spoken, less formal discourse

(Ravid & Shlesinger, 1995). Possession can also be optionally expressed morphologically by a set of possessive suffixes denoting gender, number and person which are attached to the noun stem, e.g. *gil-o* 'age-his = his age', *gil-énu* 'age-our = our age'. The Semitic morphological option, which historically preceeded the syntactic form, characterizes written, especially literary style, and appears abundantly in children's literature from early on. Nevertheless, it is rarely used in everyday discourse, except for a few lexicalized expressions such as *tori* 'my turn'.

The semantics of possessive-marked nouns is simple and transparent. The meaning of the stem does not change, and the additional semantic content is 'belongs to'. There are two problems, however, that may delay children's acquisition of such forms. One is the structural changes that nominal stems may undergo when suffixed by possessive markers. Thus, a child may succeed at a younger age in producing *gila* 'her age' from the nonchanging stem *gil* 'age' than in producing *beyta* 'her home' from the altered stem *báyit* 'home'. A second challenge is posed by the morphophonology and semantics of the possessive suffixes, which express gender, number and person. The child has to pay attention to the gender, number and morphological class of the stem, as well as to the semantics and form of the suffix. For instance, from *gil* 'age' we derive *gilo* 'his age' and *gilan* 'their (feminine) age'. In addition, possessive suffixes take allomorphic forms according to the singularity or plurality of the stem as in *shad* 'breast' and *shad-a* 'her breast', vs. *shadáyim* 'breasts' and *shad-éha* 'her breasts'. Furthermore, there are morphologically conditioned allomorphic variants of the same suffix, e.g. *-o* vs. *-iv* for 3rd person masculine singular, e.g. *im-o* 'his mother' but *av-iv* 'his father'. In sum, the issue of possessive suffixation is complex both semantically and morphologically.

The possessive noun items in our study required suffixation expressing person and gender: *-o* for 3rd person masculine, *-a* for 3rd person feminine, and *-i* for 1st person (indistinguishable by gender), plus a few irregular forms. We chose not to include all the problems entailed in this structure, because we assumed some too hard for children of the age range studied.

Denominal adjectives suffixed by -i. (See derivation examples 1, 2, 4, 5, 6, in Table 3.) Derivational morphology was represented in the study by denominal adjectives (formed from noun bases) marked by a final *-i* (Berman, 1995). Denominal *i*-suffixed adjectives display the range of interpretations typical of novel zero-derived verbs and the other morphological classes discussed by Clark & Clark (1979) and by Aronoff (1980): they are 'contextuals', since their interpretation depends on the context and the cooperation of the speaker and listener, unless lexicalized. Thus, from the noun *mishpaxa* 'family' are derived *avira mishpaxt-it* 'atmosphere familial = intimate atmosphere' and *xatuna mishpaxt-it* 'wedding familial = wedding restricted to relatives', so that the interpretation of the adjective *mishpaxtit*

is determined contextually. This makes denominal adjectives hard for children to interpret and of course to produce, unless learned by rote.

The suffix is adjusted to the gender of the noun base, *-i* for masculine and *-it* for feminine, e.g. *tiyul* (Masc) *shnat-i* 'annual trip' and *xufsha* (Fm) *shnat-it* 'annual vacation' both from *shana* 'year'. This is the last type of adjective to emerge in Hebrew child language (Ravid & Nir, 2000), and it characterizes literate expository writing (Ravid & Shlesinger, 1987). Denominal adjectives typically occur in noun-adjective constructions which may lexicalize (that is, become a lexical entry; e.g. *tayas otomáti* 'automatic pilot'), and require knowledge of the base noun and the specific, idiosyncratic meaning of the denominal adjective (Schwarzwald, 1998). Denominal adjective suffixes differ only in gender, with no allomorphs. Consequently, these suffixes are rather simple both semantically and morphologically.

Two tasks were constructed, one requiring marking possesion on nouns and the other deriving denominal *-i* adjectives from nouns (see Appendix 1).

Objectives and hypotheses

The study had two major objectives: (1) to analyse the development of spoken morphology, and (2) to examine the mutual contribution of morphological knowledge and learning the written code. In a longitudinal design, we tested children's performance twice, first in kindergarten and then in first grade, on the two oral tasks and on a written task involving a series of words.

Our predictions in respect to oral morphology were as follows:

(a) Performance will be higher on inflection than derivation since inflections are more semantically predictable and transparent. This difference was expected to emerge on both stems and suffixes because of the lower semantic difficulty inherent in inflections.

(b) No prediction was made with respect to the comparative difficulty of stems vs. suffixes as these are inherently two different systems.

(c) In regard to suffixes, the specific errors of replacing the required suffix with another legitimate suffix of the same system, i.e. confusing person, gender, and/or number on possessive nouns or gender on denominal adjectives, will be more prevalent for possessive nouns than for denominal adjectives, since the former are more complex semantically and structurally, even in the limited scope of possessives tested here.

(d) The level of change introduced to the stem will predict stem's difficulty in the two tasks. We included stems that remained unchanged when suffixed, stems that underwent slight change, i.e. vowel deletion, *t*-alternation or both, and stems that underwent substantial change, i.e. stop/spirant alternation, vowel change, or complex changes. The distinction between slight and substantial change was determined on the basis of age of acquisition and factors of frequency and transparency in Hebrew morphology

(Berman, 1985; Ravid, 1995.) In Table 3 item 0 illustrates instances of no change; items 1, 2 display slight change and the rest show substantial change. We expected scores to reflect an increasing degree of stem difficulty from 'no change' to 'slight change' to 'substantial change' in both inflection and derivation.

(e) Performance on inflection and derivation tasks will be correlated both in kindergarten and first grade, due to their similarity in construction type (both are linear construtions of stem + suffix), similarity in changes introduced to the stems when suffixed, and their prevalence in the written register.

(f) Due to age and to schooling effects, performance will improve from kindergarten to first grade.

The expected mutual contribution of spoken morphology and writing generated the following predictions:

(g) Spoken morphology and writing will be correlated both in kindergarten and in first grade.

(h) Kindergartners' spoken morphology will contribute to writing improvement from kindergarten to first grade.

(i) Kindergartners' level of writing will contribute to improvement in spoken morphology from kindergarten to first grade.

Method

The study was carried out in a school that contained a separate educational unit for kindergartners and first graders. Such units are established in Israel to facilitate children's transition from kindergarten (henceforth: K) to first grade (henceforth: G1). The three K and three G1 teachers in this unit shared a pedagogical ideology of 'whole language', were guided by the same administration, and their classes were located in adjacent open spaces so that K and G1 children often worked or played together. Kindergartners were encouraged to invent spelling as part of their drawing and playing activities, were frequently read storybooks, and listened to cassettes. No formal instruction in reading or writing was provided, but children's questions regarding spelling or reading were encouraged. First graders were formally taught to read and write, though invented spelling was still welcomed. We selected the school we did because we expected kindergartners here to be relatively advanced both in writing and in oral-literate language, and believed that the developmental discontinuity between K and G1 would be reduced.

Participants

Forty kindergartners were randomly selected from 3 classes, equally divided by gender. Their mean age in kindergarten was 5;11 (range 5;5–6;4) and in first grade 6;5 (range 5;11–6;11). Children whose mother tongue was not

Hebrew (i.e. new immigrants) or who were assessed by the teachers as having special needs (e.g. language delayed) were not included in the sample.

The same tasks, devised especially for this study, were administered in K and in G1, seven months apart.

Procedure

The children were tested individually in 4 sessions each year – K and G1 – with a few days at most between one session and the next. During each 20-minute session they both wrote dictated words and responded orally to a morphological task. Item order in the morphological tasks was counterbalanced by presenting the items in one order to half the sample and in the reversed order to the other half. Item order of dictation was counterbalanced by presenting the items in a different order to each child. The interviews were taperecorded and transcribed, as well as documented in writing by the interviewer.

Constructions of spoken morphology

Possessive marking on nouns. As explained above, possession can optionally be expressed syntactically by the inflected possessive pronoun, *shel* (*ha-gil sheli* 'my age', *ha-gil shela* 'her age'). Our task consisted of 33 items, in each of which the child was given the noun base and the separate inflected possessive pronoun, and asked to say them together in one word, e.g. 'Please say 'his voice' (*ha-kol shelo*) in one word' (answer = *kolo*).

A third of the items required inflection to first person singular 'my', a third to third person masculine singular 'his', and a third to a third person feminine singular 'her'. Items with inflection to second person singular or to plurals were not included because of the complexity of these suffixes. Three noun bases were given in plural form (e.g. *xaruz-im* 'bead-s') and three with a dual suffix (*birk-áyim* 'knee-s'). The rest (27) were in singular form. Three singular items denoted kinship terms, e.g. *íma* 'mommy'.

The task consisted of 16 masculine (e.g. *melex* 'king') and 17 feminine (e.g. *sira* 'boat') noun bases. In 13 items the stem did not change (e.g. *armon/armona* 'castle/her castle'), in 13 the change was slight (e.g. *tmuna/tmunato* 'picture/his-picture'), and in 7 items the change was substantial (e.g. '*xérev/xarba*' 'sword/her sword'; *ába/avíha* 'father/her-father') (see Appendix 1).

Instructions included 4 examples, with two stems undergoing no change and two changing. Two examples were in first person, one in third person masculine and one in third person feminine.

Denominal adjectives suffixed by -i. The denominal adjectives task consisted of 24 items, as well as four control non-denominal adjectives (e.g. *gadol* 'big'), which served as distractors. The child was given a familiar base noun

N1 and asked to supply the denominal adjective derived from N2. For example: 'A baby who looks like an *angel* (*mal'ax*) is a *baby* (*tinok*) __' (answer = *mal'axi* 'angel-ic', *tinok mala'xi* = 'angelic baby'). In eight items the stem (N1) did not change when transformed into a denominal adjective. In 16 items the stem underwent a change, in four of them slight and in 12 substantial (see Appendix 1).

All the items were equally divided between masculine and feminine noun forms of N1. To achieve N–Adj agreement in the given pair, the child had to add the suffix *-i* for masculine and *-it* for feminine. Instructions included two examples of correct derivations, one with a masculine, the other with a feminine noun. In these examples the stems underwent no change when suffixed.

Scoring the oral tasks

Each response was scored zero to two on stem and on suffix. A score of zero was assigned both to the stem and to the suffix when a child refused to answer, added no suffix or produced an unrelated form. A score of one was given to the stem when it was suffixed but ill-formed. A stem was ill-formed if it remained unchanged when a change was required, if it underwent only some of the changes required, or if it was changed incorrectly. A score of two was given to the stem when it was both suffixed and well-formed. A score of one was given to an incorrect suffix. A score of two was given to a correct suffix. The whole word score, based on the addition of score for stem and score for suffix, resulted in the following values: 0, 2, 3, 4. The score of 1 was impossible since zero on one component entailed zero on the other. Hence, we recorded the scale as 0, 1, 2, 3.

The writing test

This test consisted of eight items, each composed of two two-word agreement sets: Noun + Adjective (Masc) and Noun + Adjective (Fm). Children of the age of those in our study are familiar with all the words we used both in their masculine and feminine forms. The 32 words the children were asked to write were divided equally according to the following criteria: syntactic category – nouns or adjectives; gender – masculine or feminine forms; phonological ending – words ending either with an open syllable (in a vowel) or a closed syllable (in a consonant), since the former has been found to be more difficult for young children to spell (Levin, Korat & Amsterdamer, 1996a) (see Appendix 2).

Scoring the writing task

Spelling was scored on consonants, on vowels, and on words. The separate scoring of vowels and consonants was decided upon because vowel spelling emerges later than consonant spelling in Hebrew (Levin *et al.*, 1996a; Levin,

Share & Shatil, 1996b; Levin, Ravid & Rapaport, 1999). The scoring of consonants in a word ranged from zero to two. A score of two meant that each phoneme was represented by a relevant grapheme, i.e. the required grapheme, a homophonic grapheme (e.g. writing (*T*) TET instead of (T) TAF for /t/), or rarely by a grapheme standing for a phonologically close phoneme (e.g. writing (P) PEY instead of (B) BET for/b/). A score of one meant that at least one phoneme in the word was represented by a relevant consonant, but not all phonemes. A score of zero meant that no phoneme was spelled by a relevant consonant, which occurred when the word was spelled with random letters. Children of this age rarely distinguish between a required and a homophonic letter in their spelling (Levin *et al.*, 1996a; Levin *et al.*, 1996b; Levin *et al.*, 1999), hence this distinction was ignored in our scoring system.

While all Hebrew words are spelled with consonants, many words are not spelled with vowels. For words that need no vowel, no score was given on the spelling of vowels. Superfluous vowels were ignored in this scoring system. A score of two was given to a word spelled with correct vowels. A score of one was given to a word spelled with vowels, one or more of which were incorrect or missing. A score of zero was given when all vowels were missing. We did not code diacritic vowel marks, since they rarely appeared in children's writing.

The spelling score on a word was the average score across its consonants and vowels. Note that due to the mostly consonantal spelling in Hebrew, quite a few words had no vowel score because no vowel marking was required.

RESULTS

Morphological knowledge

Performance was predicted to be higher on inflection than derivation in both stems and suffixes, and to improve from K to G1. No hypothesis was presented with respect to the comparative difficulty of stem vs. suffix. Table 4 presents mean percentage scores, out of maximal possible scores, for stem and suffix on the two tasks, in the two grades.

A three-way ANOVA, with repeated measures on the three factors, was carried out comparing task (2 levels: inflection, derivation) by grade (2 levels: K, G1), and constituent (2 levels: stem, suffix). As expected, performance was higher on inflection than derivation, $F\ (1, 39) = 5{\cdot}62$, $p < 0{\cdot}02$, and improved with grade $F\ (1, 39) = 43{\cdot}99$, $p < 0{\cdot}001$. No significant difference was found between performance on stem vs. suffix, $F < 1$. However, significant interactions emerged between constituent and grade, $F\ (1, 39) = 10{\cdot}47$, $p < 0{\cdot}002$, and among all three factors, $F\ (1, 39) = 9{\cdot}50$, $p < 0{\cdot}004$.

TABLE 4. *Means (and standard deviations) of percentage scores on stem and suffix in the two morphological tasks by grade*

	Kindergarten		Grade 1	
	M	S.D.	*M*	S.D.
Inflection: possessive marking ($n = 33$ items)				
Stem	0·72	(0·29)	0·87	(0·15)
Suffix	0·73	(0·31)	0·89	(0·15)
Derivation: denominal adjectives ($n = 24$ items)				
Stem	0·71	(0·11)	0·80	(0·11)
Suffix	0·64	(0·26)	0·82	(0·21)

Note: Raw score range 0–2.

Table 4 indicates that the interactions stemmed from the particularly low performance among kindergartners on suffix in the denominal adjective task. Differently put, suffix turned out to be more difficult than stem for the younger group on the derivation task.

With regard to suffix, prediction (c) states that the specific errors of replacing the required suffix with another legitimate suffix of the same system, i.e. confusing person, gender, and/or number on possesive nouns or gender on denominal adjectives, will be more prevalent for possessive nouns than for denominal adjectives. This is because the suffix system is simpler for derivations. Indeed, the mean percentage of specific errors on inflection were $M = 0{\cdot}15$ (S.D. $= 0{\cdot}18$) and $M = 0{\cdot}13$ (S.D. $= 0{\cdot}11$) in K and G1, and on derivation were $M = 0{\cdot}01$ (S.D. $= 0{\cdot}03$) and $M = 0{\cdot}02$ (S.D. $= 0{\cdot}06$) in K and G1. A two way ANOVA on task (2 levels) by grade (2 levels) with repeated measures, revealed that specific errors were significantly more prevalent in inflections. Such errors were practically non-existent in derivation.

With regard to stems, we expected stem change type to affect item difficulty (prediction d). Performance was predicted to decrease from no-change stem, to slight-change, and further to substantial-change. Overall, we predicted performance to be higher on inflection than derivation and to increase with grade (predictions a and f). See the upper part of Table 5.

A three-way ANOVA, with repeated measures on the three factors, was carried out comparing stem change type (3 levels: no-, slight-, substantial-change), task (2 levels: inflection, derivation), and grade (2 levels). As expected, stem change type had a significant effect on performance, $F(2, 78) = 235{\cdot}50$, $p < 0{\cdot}001$. Likewise, performance improved with grade, $F(1, 39) = 36{\cdot}46$, $p < 0{\cdot}001$. In contrast with expectation, no significant difference was found in performance between the two tasks, $F < 1$. However, significant interactions emerged between task and grade, $F(1, 39) = 4{\cdot}27$, $p < 0{\cdot}05$, and task and stem change type, $F(2, 78) = 5{\cdot}36$, $p < 0{\cdot}007$. Table 5 indicates that

TABLE 5. *Means (and standard deviations) of percentage scores on stem and on suffix in the two morphological tasks by stem change and grade*

	Kindergarten		Grade 1	
	M	S.D.	*M*	S.D.
		Stem scores		
Inflection: Bound possesive marking				
Non-changing stem	0·79	(0·31)	0·93	(0·13)
Slightly changing stem	0·78	(0·35)	0·94	(0·14)
Substantially changing stem	0·59	(0·27)	0·75	(0·18)
Derivation: i-suffixed denominal adjectives				
Non-changing stem	0·82	(0·15)	0·90	(0·11)
Slightly changing stem	0·76	(0·14)	0·84	(0·14)
Substantially changing stem	0·62	(0·10)	0·71	(0·11)
		Suffix scores		
Inflection: Bound possesive marking				
Non-changing stem	0·76	(0·31)	0·93	(0·13)
Slightly changing stem	0·74	(0·35)	0·95	(0·14)
Substantially changing stem	0·73	(0·31)	0·89	(0·17)
Derivation: i-suffixed denominal adjectives				
Non-changing stem	0·69	(0·28)	0·85	(0·20)
Slightly changing stem	0·71	(0·26)	0·91	(0·28)
Substantially changing stem	0·58	(0·30)	0·77	(0·23)

Note: Raw score range 0–2.

overall performance improved with grade to a greater extent on inflection than derivation (0·15 vs. 0·08). The expected decrease in performance from no-change to slight change to substantial change did appear on derivation (0·86, 0·80, and 0·67). On inflection, overall performance on the stems with substantial change was lower than on stems with no-change or with slight-change, which did not differ from each other (0·86, 0·86, and 0·67).

Since stem change type had a major effect on performance for stems, it was reasonable to explore whether stem change type affected performance for suffixes as well, since stem and suffix form a word unit. The lower part of Table 5 presents the mean scores for suffixes by stem change type, task and grade. A three-way ANOVA, with repeated measures on the three factors, was carried out comparing stem change type (3 levels: no-, slight-, substantial-change), task (2 levels: inflection, derivation), and grade (2 levels). All main effects were significant: stem change, $F(2, 78) = 23{\cdot}31$, $p < 0{\cdot}001$, task, $F(1, 39) = 7{\cdot}64$, $p < 0{\cdot}009$, and grade, $F(1, 39) = 36{\cdot}47$, $p < 0{\cdot}001$. A significant interaction emerged between task and stem change type, $F(2, 78) = 6{\cdot}84$, $p < 0{\cdot}002$. Table 5 shows that performance on suffixes was lower when stem change was substantial than when it was null or slight, with a greater discrepancy for derivation than inflection. In other words, a

substantial stem change increased item difficulty, particularly on the more difficult task. In contrast, performance on suffixes did not seem to differ between no-change stems and slight change stems. Performance was systematically higher for inflection than derivation and improved with grade, as was expected.

On the possessive task, the task was designed to afford analysis of the effects of person/gender expressed in the suffix ('my', 'his', 'her'), and gender of the noun base (*melex* 'king', *sira* 'boat' Fm). A two-way ANOVA, with repeated measures on suffix category (3 levels: my, his, her) by grade (2 levels), was performed. Stem change was ignored since it is independent of suffix person/gender. The mean scores for 1st person, 3rd person Masc, and 3rd person Fm in kindergarten were $Ms = 0{\cdot}78, 0{\cdot}69, 0{\cdot}71$, and in Grade 1 $Ms = 0{\cdot}95$, $0{\cdot}86$, $0{\cdot}86$. Significant effects were found for suffix category, $F(2, 78) = 28{\cdot}57$, $p < 0{\cdot}001$, with higher performance on 1st than 3rd person, and for grade $F(1, 39) = 20{\cdot}85$, $p < 0{\cdot}001$.

A two-way ANOVA was carried out comparing gender of noun stem (2 levels: masculine, feminine) and grade (2 levels). The criterion here was performance on stem, since the gender refers to the noun base. It should be noted that stem changes do not usually differ systematically by gender of stem. The effect of stem gender was not found to be significant, $F < 1$, while the effect of grade again emerged, $F(1, 39) = 20{\cdot}39$, $p < 0{\cdot}001$.

On the denominal adjective task, the task allowed analysis of the effect of gender of the noun with which the adjective had to agree, *-i* and *-it* for masculine and feminine, respectively [e.g. 'wavy' *gali* (Masc.) and *galit* (Fm.)]. A two-way ANOVA, gender (2 levels) by grade (2 levels) was performed with performance on suffix as the dependent variable, as gender is expressed in the suffix and is independent of stem change. The means on scores for masculine and feminine respectively in kindergarten were ($Ms =$ $0{\cdot}74$ and $0{\cdot}69$), and in Grade 1 ($Ms = 0{\cdot}82$ and $0{\cdot}77$). Results indicate that the masculine suffix was easier to produce than the feminine suffix, $F(1, 39) =$ $44{\cdot}90$, $p < 0{\cdot}001$, and that performance improved with grade, $F(1, 39) =$ $44{\cdot}18$, $p < 0{\cdot}001$.

We expected performance on the two oral morphology tasks to correlate with each other both in kindergarten and in first grade. The correlations were $r = 0{\cdot}54$, $p < 0{\cdot}001$, and $r = 0{\cdot}55$, $p < 0{\cdot}001$, for K and G1, respectively.

Writing

Improvement in writing was obviously expected in the transition from kindergarten to first grade due to schooling and age. Scores were expected to be higher on consonants than on vowels. Mean scores (and standard deviations) for writing consonants and vowels in K were $M = 0{\cdot}50$ (S.D. = $0{\cdot}33$) and $M = 0{\cdot}29$ (S.D. = $0{\cdot}34$), respectively, and in G1 were $M = 0{\cdot}77$

(S.D. = 0·16) and (S.D. = 0·32). A two-way ANOVA, with repeated measures on the two factors, was carried out comparing phoneme type (2 levels: consonant and vowel) and grade (2 levels). As expected, performance was higher on consonants than vowels, $F(1, 39) = 44{\cdot}31$, $p < 0{\cdot}001$, and improved with grade, $F(1, 39) = 79{\cdot}46$, $p < 0{\cdot}001$. A more detailed analysis of the development of writing is to be found in Levin *et al.*, (1999).

Morphological knowledge and writing

Morphological knowledge was expected to correlate with level of writing. Table 6 presents the correlations between morphological scores on the

TABLE 6. *Correlations between scores on morphological tasks and on writing in kindergarten and in grade 1*

	Inflection	Derivation	Total
Kindergarten			
Consonant writing	0·45**	0·43**	0·50***
Vowel writing	0·25	0·26	0·29†
Word writing	0·40*	0·40*	0·45**
Grade 1			
Consonant writing	0·59***	0·42**	0·57***
Vowel writing	0·47**	0·47**	0·53***
Word writing	0·60***	0·48**	0·60***

Note: †$p < 0{\cdot}10$, *$p < 0{\cdot}05$, **$p < 0{\cdot}01$, ***$p < 0{\cdot}001$.

derivation and inflection tasks on the one hand, and writing of consonants, of vowels, and of words (i.e. consonants and vowels) on the other. In K, morphological scores on the two tasks correlated significantly with writing of consonants and of words but not of vowels. However, the correlation of vowel writing with morphology approached significance when morphological scores were combined across the two tests. In G1, morphological scores correlated significantly with writing of consonants, of vowels, and of words. Though the data suggest an increase in the correlations with schooling, the differences between the parallel correlations in K and G1 were not significant.

We hypothesized that morphological knowledge would contribute to the development of writing, and that writing would enhance morphology acquisition. Since both oral morphology and writing improved with grade and tended to correlate in K and in G1, the level of each domain in K should correlate with that of the other in G1. However, we predicted that morphological knowledge would contribute to writing and writing to morphological knowledge, after controlling for the concurrent inter-

TABLE 7. *Hierarchical regressions predicting Grade 1 writing from kindergartners' writing and performance on morphological tasks*

Step and variable Assessed in K	Statistic		
	R^2 changes	F to enter	$p <$
		G1 Word writing	
1. Word writing	0·53	43·18	0·001
2. Inflection	0·02	1·91	0·17
or			
2. Derivation	0·03	2·39	0·13
or			
2. Inflection & derivation	0·03	2·83	0·10
		G1 Consonant writing	
1. Consonant writing	0·51	40·21	0·001
2. Inflection	0·02	1·58	0·22
or			
2. Derivation	0·01	0·46	0·50
or			
2. Inflection & derivation	0·02	1·49	0·23
		G1 Vowel writing	
1. Vowel writing	0·27	14·23	0·001
2. Inflection	0·07	3·96	0·054
or			
2. Derivation	0·10	5·94	0·02
or			
2. Inflection & derivation	0·10	6·19	0·02

correlations between them and the developmental continuity of each from K to G1.

To test the contribution of morphological knowledge in K to the development of writing from K to G1, two step hierarchical regressions were computed predicting the level of writing in G1. In step 1 writing in K was found to substantially contribute to the variance in writing in G1. This was shown in three separate analyses pertaining to writing of words, of consonants, and of vowels. In step 2, after removing this contribution, we examined whether scores on morphological tasks showed an additional contribution to G1 writing. Nine regressions were performed to measure the effects of kindergartners' scores on inflection, on derivation, and on the two tasks combined, on the writing of words, of consonants and of vowels. The unique contributions of oral morphology to writing were significant only when vowel writing in G1 was predicted. It explained an additional 7% –10% of the variance. Oral morphology had no unique significant contribution to consonant or word writing in G1. See Table 7.

To test the contribution of writing in K to the development of oral

TABLE 8. *Hierarchical regressions predicting Grade 1 morphological knowledge from kindergartners' morphological knowledge and writing*

Step and variable Assessed in K	Statistic		
	R^2 changes	F to enter	$p <$
		G1 Inflection	
1. Inflection	0·56	47·78	0·001
2. Word writing	0·007	0·62	0·44
or			
2. Consonant writing	0·02	1·86	0·18
or			
2. Vowel writing	0·006	0·93	0·94
		G1 Derivation	
1. Derivation	0·49	36·44	0·001
2. Word writing	0·11	9·70	0·004
or			
2. Consonant writing	0·10	9·41	0·004
or			
2. Vowel writing	0·06	4·76	0·04
		G1 Inflection & derivation	
1. Inflection & derivation	0·62	61·94	0·001
2. Word writing	0·04	4·80	0·03
or			
2. Consonant writing	0·06	6·60	0·01
or			
2. Vowel writing	0·02	1·60	0·21

morphology from K to G1, two-step hierarchical regressions were computed predicting the level of morphological scores in G1. In step 1, morphological scores in K were found to substantially contribute to the parallel scores in G1. This was shown in three separate regression analyses pertaining to inflection, derivation and the two tasks combined. In step 2, after controlling for these contributions, we examined whether writing in K showed an additional contribution to morphology in G1. Nine regression analyses were carried out predicting inflection, derivation and the two tasks combined, from writing of words, consonants and vowels. The unique contributions of writing to oral morphology were found to be significant when levels on the derivation task or the two tasks combined were predicted. Writing explained an additional 6%–11% of the variance on derivation. When scores on inflection were predicted the contributions of writing were not found to be significant. See Table 8.

The results of the hierarchical regressions provide a partial support for the model of mutual contribution between acquisition of morphological knowledge and of the written code.

Discussion

Our discussion will focus on two issues: (1) the development of oral morphology assessed in this study, and (2) the mutual contribution of the developing grasp of morphology and progress in acquiring the written code. The two oral constructions in our study are late-emerging systems which do not appear in the language of preschoolers (Berman, 1997). The acquisition of these systems is delayed for two main reasons: one, because there are more transparent and regular means of expressing the same notion which are available to the child earlier on; and two, because they require integrative knowledge of other systems and of specific discourse genres of which they are typical (Ravid & Avidor, 1998).

Our primary expectation was that children would succeed better in inflecting possessive nouns than in deriving denominal adjectives. Generally, derivation proved to be harder than inflection, particularly in G1, both on stem and on suffix. This discrepancy between inflections and derivations emerged despite the commonality of the formal operation required in the two tasks: linear suffixation of stems that undergo formal changes shared by the two systems.

Inflectional systems are typically acquired earlier than derivational systems due to their obligatoriness, general applicability, frequency, transparency, and regular and predictable semantics (Bybee, 1985). Hebrew is no exception: the onset of inflectional acquisition occurs before age two, and by age three all inflectional systems are in use, though complete mastery of all allomorphic morphophonological forms takes years (Berman, 1985; Ravid, 1995). The only exceptions to this early acquisition are two optional inflectional systems: possessive (genitive) noun marking and accusative verb marking (e.g. *re'itiv* 'I-saw-him'). Both of these are pre-empted by syntactic forms in common language usage and certainly in child-directed speech.

Analytic expression of possession in Hebrew is simpler, more transparent and salient, and more regular than the morphological option from a number of aspects. First, in the syntactic form, the noun stem is always left unchanged, whereas in morphological expression it may undergo change. Compare, for example, the noun stem *késef* 'money' in the syntactic phrase *ha-késef shelánu* 'the-money ours = our money' vs. the single word *kaspénu* 'our money'. The child may not find it initially easy to relate the bound stem to its free, familiar form in terms of comprehension, while correct production, as we have seen, additionally requires a systematic grasp of the ways noun stems change in Hebrew. Secondly, in the syntactic phrase the semantics of the genitive is expressed clearly and overtly in the particle *shel* 'of' but not in the morphological word. Finally, marking the genitive particle *shel* 'of' for number, gender, and person requires a lesser cognitive load than marking the noun stem directly: in syntactic expression the child need only learn the

inflection of the single preposition *shel* 'of', whereas in morphological expression each stem and stem class has to be learned separately. Moreover, *shel* takes a transparent and regular inflectional marking. In contrast, many noun stems undergo changes that have to be learnt systematically or by rote, and the possessive markers require a number of allomorphs according to the type of stem. For example, the third person masculine singular suffix on singular stems can be either *-o* as in *imo* 'his mother' or *-iv* as in *axiv* 'his brother', and takes the form of *-av* on plural stems, e.g. *sandalav* 'his sandals'.

Denominal *i*-suffixed adjectives, as derivational forms, have neither general applicability nor are they semantically regular and transparent. The N-Denominal Adjective is a structural option Hebrew offers for expressing complex subcategorization – a phrase with the meaning 'N1 with the property of N2', e.g. *shémesh avivit* 'spring sun' = sun with the properties of the sun in spring', from *aviv* 'spring'. This option is in a sense comparable to the colloquial *-y* suffixed adjectives in English, e.g. *Beethoveny* (Clark & Clark, 1979), but their semantics also overlaps with literate, non-Germanic adjectives in the English lexicon, such as *intensive*, *domestic*, *formulaic*. In order to derive the denominal adjective from a noun, the base noun has to be 'dissolved' into its component properties to select the specific property that will be carried over to the derived adjective. The same *i*-suffixed adjective takes on different meanings in different constructions, e.g. *óxel beyti* 'homecooked-like food'; *tipus beyti* 'a domestic type = one who likes to stay at home'. This is similar to Bolinger's (1967) note that the meaning of *criminal* differs in *criminal lawyer* and *criminal act*, and is in line with Markman's observation that adjectives adjust their meanings to the context in which they appear (1989: 119).

The acquisition of denominal *i*-suffixed adjectives accompanies later lexical and morphological development and a growing familiarity with speaker preferences for new-word formation and levels of register and genre-associated usage (Berman, 1997). Ravid & Nir (2000) have found that *i*-suffixed adjectives initially appear in the spontaneous speech of five-to-six-year-old kindergartners as lexicalized familiar forms (e.g. *dati* 'religious', *rusi* 'Russian') and as innovative erroneous forms (*xatani* 'groom-like = neatly dressed'). Similar examples are found in child language data bases, e.g. Ran, M, 5;4 termed his father's gun *ekdax barzeli* 'gun metallic = metal gun' from *barzel* 'iron' (Berman, 1997), and Itamar (7;5) called himself *yéled savlanuti* 'patiency child' from *savlanut* 'patience' (Ravid, diary data).

It is particularly interesting to examine children's knowledge at this age, when they are making the transition from kindergarten to school. At this time, inflectional errors are infrequent and restricted to individual words (Ravid, 1995), there is a sharp drop in the number and variety of childish

derivational errors according to teacher reports, and language knowledge and usage become less local and more integrated (Berman, 1995, 1997). We offer below an analysis of erroneous stem and suffix productions in our study. This analysis constitutes a window on children's grasp of these two late-developing systems, as well as on their current knowledge of Hebrew morphophonological operations which have not been studied systematically before.

Errors that were scored as failures indicated that the child did not grasp the option of creating a unified linguistic unit from the stem and suffix, came up with a form borrowed from other morphological systems outside the scope of the study tasks, or produced idiosyncratic and ill-formed constructs. Such forms represent what Ravid & Avidor (1998), following Berman (1995), term FLUX. For example, in response to *xófesh* 'freedom' also colloquial 'vacation', one child gave the plural form *xofashim* 'vacations', yielding the compound *yéled xofashim* 'vacation child' instead of *yéled xofshi* 'free child'. Another child produced the ill-formed bound compound (*smixut*) *tsiporney shelo* for *tsipornav* 'his nails'; and another gave the resultative adjective *matúax* 'tense' in response to similar-sounding *matéxet* 'metal', instead of *mataxti* 'metallic'. The overwhelming majority of incorrect responses in both kindergarten and first grade, however, went beyond these initial formations and were more mature in the sense that they represented possible forms in adult language.

Suffixes. While in general performance on both stem and suffix was higher for inflection, errors of interchanging suffixes within the same system (e.g. 1st for 3rd person in possessives, masculine *-i* for feminine *-it* in adjectives) were more prevalent on this easier inflectional task. This finding illustrates the role of suffix complexity *per se*: the possessive suffix system maps more information and is structurally more complex and opaque than the denominal gender suffix system. Possessive suffixes express person, number and gender of suffix, and have stem-dependent suffixal allomorphs, while denominal adjective suffixes convey gender alone with no stem dependence and allomorphic variation.

Erroneous responses on possessive suffixes were of three types. The most prevalent error type was using regularized allomorphs where stem-specific forms were required, e.g. *ab-a* for correct *av-íha* 'her father' from *ába* 'father'. Such errors were also found in the opposite direction using marked, stem-specific and stem-plural suffixes for less marked ones, e.g. *xerb-íha* for *xarb-a* 'her sword'. Errors of this sort which accounted for about 35% of suffix responses in K and 18% in G1, indicate a robust grasp of the possessive suffix system in Hebrew. It should be noted, however, that we included only parts of the possible system in our task, ignoring 2nd person and plural suffixes altogether. We believe that had we sampled cases representing the entire system, we would have had many more errors of this

type. Indeed, a full mastery of possessive suffixation may even be beyond many Hebrew speaking adults.

Another type of suffix error in possessive nouns was also structural in nature and consisted of interchanging stem-dependent allomorphs. In 4·3% of the errors in K and 5·7% of those in G1, children employed the wrong number-dependent allomorphs, e.g. *kap-av* for correct *kap-o* 'his spoon', *sirat-éha* for correct *sirat-a* 'her boat', using plural-stem suffixes on singular stems.

The third type of error was semantic in nature and consisted of substituting the 1st person suffix for the 3rd, e.g. *sirati* 'my boat' for *sirata* 'her boat' (6·3% of children's possessive suffix responses in K and 3·2% in G1). In contrast, gender errors on the possessive suffix were almost nonexistent (less than 1%), illustrating the greater cognitive difficulty of person vs. gender that was also found by Malenky (1997). This is not surprising in view of the fact that gender is an inherent inflectional category in nouns, while genitive marking is a relational category of the noun and refers to its role in larger structures (Anderson, 1985).

Stems. While the discrepancy between inflection and derivation seems to result from the greater semantic opacity of the latter, the structural factor also appears to constitute an obstacle to correct performance. We classified the stems in the two tasks into three categories according to the level of stem change under suffixation: no change (*stav*/*stavit* 'autumn/autumnal'), slight (*gav*/*gabi* 'back/my back') and substantial change (*emet*/*amiti* 'truth/true'). As expected, the greater the change, the fewer the correct responses. Moreover, slightly-changing stems presented as little difficulty as non-changing stems on the easier inflectional task, but were between no change and substantial change on the harder derivational task. Stem change also affected success on suffix production. Suffix scores were lower on words with substantially changing stems than on words with slightly- or non-changing stems, especially on the derivational task. These results suggest an interaction between the challenges posed by semantics and form, and the interface between word constituents, i.e. stem and suffix. Suffixes are bound morphemes and therefore find their lexical existence within the word, in intimate relation with the stem.

Analysis of children's incorrect stem productions in both age groups indicates that kindergartners and first graders are cognizant of the prevalent classes of stems and familiar with typical associated stem changes, but do not yet possess a full systematic knowledge of the mechanisms involved. For example, children tended to retain the stop or spirant in the given stem, e.g. **kafo* for *kapo* 'his spoon' from *kaf* '*spoon*', **duvit* for *dubit* 'bearlike' from *dov* 'bear'. This error type is prevalent especially in inflection in earlier ages (Ravid, 1995). Erroneous responses involving the feminine bound-stem

suffix *-at* are indicative of children's perception of the central role of *-t* [marked by T (TAF) in the spelling] as a function element. It was either inserted in the wrong environment – on masculine nouns, on feminine nouns which do not end with an *a*, or on nouns with a non-stressed final *a* – e.g. **laylatit* for *leylit* 'nocturnal' from *láyla* 'night', or deleted in the wrong environment from stems ending with *t*-final suffixes, e.g. **mashroko* for *mashrokito* 'his whistle' from *mashrokit* 'whistle', ending with the suffix *-it*. Indeed, such errors echo actual cases in adult language where final suffix *-t* is omitted (e.g. irregular *xagigi* instead of *xagigati* 'festive' from feminine *xagiga* 'celebration', and all non-root *t*-final stems in plural suffixation, e.g. *xanut/xanuy-ot* 'shop/shops'). However, there was not even a single case of deletion of what were obviously root *t*'s, e.g. in *délet* 'door', *emet* 'truth', showing awareness of morphological categories.

Stem permutations in complex changes are also indicative of a broad, though not systematic, underpinning of morphological knowledge. Responses on so-called '*segolate*' *CéCeC* items show children's perception of the two major stem changes in this morphological class: *CéCeC* to *CCaC-* in plural suffixation (e.g. *kélev/klavim* 'dog/dogs'), and *CéCeC* to *CVCC-* in singular suffixation (e.g. *séfer/sifriya* 'book/library', *dérex/darko* 'way/his way'). Thus, children gave **dlato* for *dalto* 'his door' from *délet* 'door' (cf. plural *dlatot*), and **ksafit* for *kaspit* 'monetary' from *késef* 'money' (cf. plural *ksafim* 'monies'). All possible inappropriate vowels showed up in *CéCeC* forms, e.g. **lixma* for *laxma* 'her bread' from *léxem* 'bread' (cf. *séfer/sifra* 'book/her book').

This analysis of erroneous stem changes indicates that preschoolers and first graders are well on the road to morphological mastery. Full stem preservation, a prevalent error in early childhood, was not evidenced except in a small number of stems that required a complex change, especially those with double roots and idiosyncratic bound forms; root *t*'s were always retained as already indicated; and single vowel deletion, the most pervasive type of stem change in Hebrew, was performed correctly across the board. At this stage of their linguistic development, our subjects were still challenged by complex changes in stems that did not appear to belong to familiar systems with numerous exemplars, e.g. *milxama/milxamtit* 'war/warlike'.

Morphology and writing. Our study yielded partial support for the bootstrapping model linking language and literacy, and specifically the development of oral morphology and learning of the written code. Correlations were found between level of early forms of writing and morphology in kindergarten and even more so in first grade. Moreover, a pronounced increase was found in morphological knowledge from K to G1, which can partly be accounted for by the obvious improvement in reading and writing. Furthermore, the level in each of the two domains (morphology and writing) contributed uniquely – though not across the board – to development in the

other. Kindergartners who were more advanced in writing in K progressed more in derivational morphology from K to G1, even after controlling for the contribution of writing in K to later writing in G1. Concomitantly, kindergartners who outperformed their peers on morphology in K, progressed more in writing vowels from K to G1, even after removing the contribution of morphology in K to the variance of morphology in G1. While these results, taken together, may point at a reciprocal relationship between morphology and writing acquisition, the specific connections between these two domains deserve further examination.

Three possible explanations, which are not mutually exclusive, might be offered for this writing-morphology interface: a language-specific explanation based on the extensive reflection on spelling of the morphological infrastructure of Hebrew; a (meta)linguistic explanation based on the network of connections among phonological, orthographic and morphological awareness and their contributions to reading and spelling; and an ecological explanation arguing that similar home environments and common literacy-related activities further the development of both writing and morphology.

Because of the synthetic nature of Hebrew, sensitivity to its morphological infrastructure should provide a powerful clue to its spelling, and *vice versa*. Lexical entries derived from the same root have the same root letters; words that share a stem have the same stem letters; same affixes are spelled alike; and common patterns employ the same pattern letters. Hence, sensitivity to morphemic connections between entries – at the root, stem, affix or pattern level – makes it possible to derive unknown spellings from known ones. Concomitantly, getting to know the spelling of semantically related words should contribute to a grasp of the morphemic connection between them. Note that our scoring system for the writing task reflected primarily phonological rather than morphological knowledge. However, it also reflected orthographic considerations such as marking final gender-related vowels (e.g. masculine *e* and feminine *a*) by letters. Thus, morphological knowledge and its expression in spelling is reflected to some extent in our writing scores.

A second explanation, applicable not only to Hebrew but also to other languages with alphabetical scripts, is that metalinguistics in general, and phonological awareness in particular, are related both to spelling acquisition and to the development of morphological awareness. Writing and reading in an alphabetical system are dependent on grapho-phonemic connections which require phonological awareness (e.g. Wagner & Torgesen, 1987; Bryant, Bradley, MacLean & Crossland, 1989; Bryant, MacLean, Bradley & Crossland, 1990; Ball & Blachman, 1991; Bentin & Leshem, 1993; Shatil, Share & Levin, 2000). Phonological awareness is also at the base of morphological awareness (Malenky, 1997). Consequently, we can expect a network of connections between phonological awareness, morphological

awareness, writing, and reading, that may promote each other (Carlisle & Nomanbhoy, 1993).

The final explanation for the relationship between spoken morphology and writing is environmental: writing and morphological awareness are both fostered by literate home environments. Parents provide preschoolers with a wide range of experiences – joint storybook reading, alphabetic book reading, assistance in writing, alphabet teaching with magnetic letters or blocks – that are correlated with various aspects of children's emergent literacy (Baker, Fernandez-Fein, Scher & Williams, 1998). It is often argued that these experiences play a causal role in enhancing literacy. The hypothesis that a particular activity, such as storybook reading, contributes uniquely and substantially to a specific skill like word recognition is hard to examine conclusively because of confounding variables in home environment (Scarborough & Dobrich, 1994); nevertheless, the general implication that home environment promotes literacy is still well founded. Studies have shown that literacy-oriented activities are prevalent today in a wide range of SES groups, but are more prevalent in higher SES homes (Baker *et al.*, 1998, Korat & Levin, in press).

Various experiences at home should promote children's morphology and spelling. Joint storybook reading can be expected to enhance knowledge of late acquired morphological structures that occur frequently in written narratives. The oral morphological structures we used in this study, particularly the bound morphemes of possession, are typical of the written register and the storybook genre. Therefore, it is reasonable to expect exposure to storybooks to contribute to this kind of morphological knowledge. By the same token, exposure to books may enhance spelling acquisition, particularly when combined with parental mediation of grapho-phonemic relations (Baker *et al.*, 1998). Indeed, exposure to storybooks among first graders, measured by TRT (Title Recognition Test) has been found to correlate with various measures of spelling, even after the contribution of phonological abilities to spelling has been partialled out (Cunningham & Stanovich, 1998). Literate activities at home, including exposure to print and writing, have also been found to correlate with preconventional writing among preschoolers of middle-low to low SES, even after the contributions of SES and maternal literacy were partialled out (Aram, 1998). Finally, experience with ABC books at home and parental involvement in children's attempts to write have both been shown to promote the early development of spelling (Baker *et al.*, 1998). In sum, children who grow up in a literacy-oriented home can be expected to be more advanced both in oral morphology and in writing.

Since writing and morphology may be connected through a multitude of mechanisms, more research, including intervention studies, is needed to understand why and how they are related. Recent studies in several languages

(Largy *et al*., 1996; Aidinis & Nunes, 1997; Nunes *et al*., 1997; Totereau *et al*., 1997) have already made important strides in this direction by showing connections between morphological awareness of particular structures in the language and the acquisition of their spelling.

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APPENDIX I

STIMULI (FREE STEMS) AND CORRECT RESPONSES (BOUND STEMS) FOR THE ORAL MORPHOLOGY TASKS

I *Possessive Nouns*

Possessive suffix type / Stem type …	1st person singular		3rd person singular masculine		3rd person singular feminine	
	Free	Bound	Free	Bound	Free	Bound
Singular stem/No change						
Masculine	1. *xaver* 'friend'	*xaveri*	5. *kol* 'voice'	*kolo*	10. *armon* 'palace'	*armona*
	2. *xatul* 'cat'	*xatuli*	6. *bakbuk* 'bottle'	*bakbuko*	11. *kadur* 'ball'	*kadura*
Feminine no suffix	3. *kos* 'glass'	*kosi*	7. *ir* 'city'	*iro*	12. *tsipor* 'bird'	*tsipora*
Feminine *-t*	4. *karit* 'pillow'	*kariti*	8. *mashrokit* 'whistle'	*mashrokito*	13. *xanut* 'shop'	*xanuta*
Kinship terms			9. *ax* 'brother'	*axiv*		
Singular/changing stem Sl = slightly changing stem Sb = substantially changing stem						
Masculine *CéCeC*	14. *yéled* 'boy' Sb	*yaldi*	19. *mélex* 'king' Sb	*malko*	23. *léxem* 'bread' Sb	*laxma*
Feminine *-a*	15. *mita* 'bed' Sl	*mitati*	20. *tmuna* 'picture' Sl	*tmunato*	24. *sira* 'boat' Sl	*sirata*
Feminine no suffix	16. *ózen* 'ear' Sl	*ozni*	21. *délet* 'door' Sb	*dalto*	25. *xérev* 'sword' Sb	*xarba*
Both genders: stop/spirant	17. *gav* 'back' Sl	*gabi*	22. *kaf* 'spoon' Sl	*kapo*	26. *af* 'nose' Sb	*apa*
Kinship terms	18. *ima* 'mommy' Sl	*imi*			27. *ába* 'daddy' Sb	*aviha*
Plural/Changing stem						
Masculine	28. *sandalim* 'sandals' Sl	*sandalay*	30. *xaruzim* 'beads' Sl	*xaruzav*	32. *gafrurim* 'matches' Sl	*gafrurého*
Feminine/dual	29. *birkáyim* 'knees' Sl	*birkay*	31. *tsipornáyim* 'nails' Sl	*tsipornav*	33. *shináyim* 'teeth' Sl	*shinéha*

11 *Denominal i-suffixed Adjectives*

Suffix gender Stem type …	Masculine suffix *-i*		Feminine suffix -it	
	Free stem	Bound stem	Free stem	Bound stem
No change	1. *mal'ax* 'angel' 2. *tsarfat* 'France' 3. *dimyon* 'imagination' 4. *gal* 'wave'	*mal'axi* 'angelic' *tsarfati* 'French' *dimyoni* 'imaginary' *gali* 'wavy'	5. *barvaz* 'duck' 6. *stav* 'autumn' 7. *shimush* 'usage' 8. *aviv* 'spring'	*barvazit* 'duck-like' *stavit* 'autumnal' *shimushit* 'useful' *avivit* 'spring-like'
Changing stem Sl = Slightly changing stem Sb = Substantially changing stem				
Masculine	9. *báyit* 'house' Sb 10. *tsad* 'side' Sb 11. *kélev* 'dog' Sb 12. *xóref* 'winter' Sl 13. *xófesh* 'freedom' Sl	*beyti* 'domestic' *tsdadi* 'side' *kalbi* 'canine' *xorpi* 'wintry' *xofshi* 'free'	14. *láyla* 'night' Sb 15. *késef* 'money' Sb 16. *xéresh* 'silence' Sb 17. *dov* 'bear' Sb 18. *mélex* 'king' Sb	*leylit* 'nocturnal' *kaspit* 'monetary' *xarishit* 'silent' *dubit* 'bearlike' *malxutit* 'royal'
Feminine	19. *emet* 'truth' Sb 20. *matéxet* 'metal' Sb 21. *shana* 'year' Sl	*amiti* 'true' *mataxti* 'metallic' *shnati* 'annual'	22. *harim* 'mountains' Sb 23. *xagiga* 'celebration' Sl 24. *milxama* 'war' Sb	*hararit* 'mountainous' *xagigit* 'festive' *milxamtit* 'warlike'

APPENDIX 2

THE WRITING TEST

THE TEST CONSISTED OF 16 NOUN-ADJECTIVE PAIRS IN EIGHT MASCULINE/FEMININE SETS.

1. *kéves raze* sheep, Masc thin, Masc	'thin sheep, Masc'	*kivsa raza* sheep, Fm thin, Fm	'thin sleep, Fm'
2. *séfer nifla* book, Masc wonderful, Masc	'wonderful book, Masc'	*sifriya nehdéret* library, Fm wonderful, Fm	'wonderful library, Fm'
3. *ben yafe* boy, Masc handsome, Masc	'handsome boy, Masc'	*bat yefehfiya* girl, Fm beautiful, Fm	'beautiful girl, Fm'
4. *aron varod* wardrobe, Masc pink, Masc	'pink wardrobe, Masc'	*aronit vruda* closet, Dim, Fm pink, Fm	'pink closet, Fm'
5. *more metsuyan* teacher, Masc excellent, Masc	'excellent teacher, Masc'	*mora metsuyénet* teacher, Fm excellent, Fm	'excellent teacher, Fm'
6. *kafé ta'im* coffee, Masc tasty, Masc	'tasty coffee, Masc'	*uga te'ima* cake, Fm tasty, Fm	'tasty cake, Fm'
7. *tale savéa* lamb, Masc satiated, Masc	'satiated lamb, Masc'	*ez zalelanit* goat, Fm greedy, Fm	'greedy goat, Fm'
8. *pétsa meluxlax* wound, Masc dirty, Masc	'dirty wound, Masc'	*taxbóshet meluxléxet* binding, Fm dirty, Fm	'dirty binding, Fm'