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Morphological knowledge without morphological structure

Morphology-prosody interface in the first Hebrew verbs*

Galit Adam & Outi Bat-El
The Open University of Israel/Tel-Aviv University

During the one-word stage, Hebrew-speaking children have only one form for each verb paradigm, and this is usually the free stem. Crucially, the children tend not to produce verbs with inflectional suffixes, although their prosodic phonology allows them to do so. We argue that this phenomenon reflects the children's capacity to distinguish between stems and suffixes (by identifying the stem) before they start producing the morphological paradigm. That is, some morphological knowledge appears before this knowledge has a direct surface manifestation in the children's speech.

1. Introduction

When children do not exhibit an inflectional paradigm in their speech, i.e., when they have only one form for each verb paradigm, we are tempted to assume that they have not yet acquired the relevant morphological knowledge.[1] This is indeed, a straightforward simple assumption, but as we argue in this paper, not at all correct.

We discuss here the morphological stage of Hebrew speaking-children, where they have only one form for each verb paradigm. The crucial point is that this form is, in most cases, the surface stem (3rd person masculine singular), and not a suffixed one (Berman & Armon-Lotem 1997; Armon-Lotem & Berman 2003). This phenomenon has been reported also in studies of the acquisition

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1. The term "paradigm" refers here to a set of inflected forms sharing a stem.

of languages such as English (Brown 1973; Demuth 1994; Gerken 1996) and Sesotho (Demuth 1994).

The Hebrew data are striking for two reasons. First, the type-frequency of suffixed forms in the adult language is much higher than that of bare stems (see §3). Second, the suffixes are in prominent prosodic positions (i.e., stressed and/or final), which are usually acquired before non-prominent positions (Echols & Newport 1992). Nevertheless, the suffixes are hardly ever produced at the stage under consideration here.

We show that prosody cannot explain the rarity of suffixed forms, since at the relevant morphological stage the children produce nouns that are prosodically identical to suffixed verbs. Neither can type-frequency, as noted above, explain this phenomenon, given that there are many more suffixed verbs in Hebrew than non-suffixed ones.

We argue that the absence of inflectional paradigms and the rarity of suffixed verbs in the children's speech, tell us about the presence of morphological knowledge, rather than its absence; that is, what we do not see (or more accurately, do not hear) is not necessarily non-existing.

Our claim is compatible with that of Borer & Rohrbacher (2002), who argue for a syntactically Full Competence approach, whereby the functional projections are present at the starting point of acquisition, even though the functional morphemes are absent. We consider this issue from a different perspective, showing that the children have the phonological facilities to produce the suffixes, but nevertheless do not do so. Moreover, we argue that the children draw a concrete distinction between lexical and functional material. Along the lines of Demuth (1994), we suggest a phonological acquisition model, which accounts for the suffixless starting point, as well as the gradual emergence of the inflectional suffixes.

We assume that the Hebrew-speaking children perceive the different phonological content of the various forms of a verb, say *nafál* "he fell" and *nafál-ti* "I fell". The fact that they use the same form for both of them, *fál* or *afál*, suggests that they also perceive the relation between the forms, i.e., they perceive the paradigm. Otherwise we would expect rote-learned words with different phonological structure (*fál*/*afál*, *fáti* respectively), which match their phonological stage evident by the production of nouns (cf. *dá*/*adá* for *yaldá* "girl" and *báta* for *ambátya* "bath"). Moreover, the fact that they select the stem in the production of all forms suggests that they distinguish between the stem and its suffix (at least they identify the stem), which means that they are responsive to word internal structure.

We begin the discussion (§1) with a description of the prosodic structure of Hebrew verbs, and the role of prosody in the relevant inflectional paradigms. We note that most verb forms are either disyllabic with final stress or trisyllabic with penultimate stress. We then turn (§2) to data from the acquisition of Hebrew nouns and provide an Optimality Theoretic analysis of the prosodic phonology at the Minimal Word stage of acquisition, which is the stage relevant to our study. We show that at this stage, all words are maximally disyllabic with final or penultimate stress. At this juncture, the puzzle is revealed (§3): Why do children not produce suffixed verbs although their prosodic phonology allows them to do so? Moreover, why do children not produce suffixed verbs given their high type-frequency compared to free stems?

As a background for the proposal, we introduce our approach to morphology (§4.1). We adopt the Item-and-Process approach, whose translation into the framework of Optimality Theory is that affixation (and morphological processes in general) is triggered by constraints, rather than by morphemes in the input. The solution to the puzzle is then offered (§4.2), in terms of interaction between phonological and morphological (affixation) constraints. We argue that the children at this stage, like adults, have a stem as an input, and this accounts for their ability to identify stems. The absence of suffixed forms is due to the low ranking of the morphological (affixation) constraints, crucially below the constraint that requires the right edge of the input stem to coincide with the right edge of the prosodic word. We conclude the discussion (§5) with remarks on the lexical representation in the child's grammar.

2. The prosody-morphology interface in Hebrew verb paradigms

The effect of prosodic constraints on Hebrew verbs is reflected in the prosodic structure of verbs and the alternation in the inflectional paradigms (Bat-El 1989, 1994, 2003a; Ussishkin 2000; Graf & Ussishkin 2003).

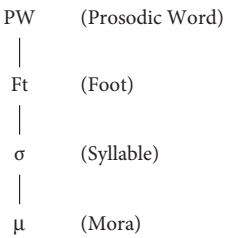
Uninflected verbs in Hebrew are usually disyllabic, either at the word level (e.g., *gamár* "he finished") or at the stem level (e.g., *it*kabél "he was accepted").[2] Stems plus inflectional suffixes (the derivational prefix *it-* is ignored) are disyllabic (e.g., *gamr-á* "she finished", *it*kabl-ú "they were accepted") or trisyllabic (e.g., *gamár-ti* "I finished", *it*kabál-nu "we were accepted"). Disyllabicity thus serves as the minimal and maximal bound of the verb size, though in the case of trisyllabic inflected verbs, it is overpowered by other requirements (to be discussed below).

2. (i) Derivational prefixes are underlined. (ii) There are a few monosyllabic stems, such as *ra¢* "he ran" and *kam* "he got up". (iii) We do not consider the future forms of verbs here, since, as argued in Berman (1985) among others, the concept of future is not yet acquired at the stage relevant for present study.

Disyllabicity is related to the notion of the Minimal Word (Prince 1980; Broselow 1982; and McCarthy & Prince 1986 et. seq.), which often serves as the minimal bound only. English and Lardil, for example, do not allow content words smaller than two moras or two syllables respectively. In Hebrew verb morphology, the Minimal Word serves as both the minimal and maximal bound (though there are a few monosyllabic verbs).

As emphasized in McCarthy & Prince (1995), the notion of the Minimal Word is derived from the preference of a binary foot (Prince 1980; McCarthy & Prince 1986, 1990; Hayes 1991), and the prosodic hierarchy (Selkirk 1980; Nespor & Vogel 1986):

(1) The prosodic hierarchy



The prosodic hierarchy implies that the prosodic word dominates at least one foot. This, in conjunction with the assumption that feet are binary under a syllabic or a moraic analysis, implies that the prosodic word is minimally disyllabic or bimoraic.

Hebrew is a quantity insensitive language, as its phonology does not provide evidence for weight contrast. There are no phonemic long vowels in Hebrew, and stress does not distinguish between CV and CVC syllables (see Bat-El this volume). That is, stress can reside on a final CV or CVC syllable (e.g., *tirá* "castle", *yaldá* "girl", *nagár* "carpenter", *rakdán* "dancer"), and, to a lesser extent, on a non-final CV or CVC syllable (e.g., *ʃóko* "hot chocolate", *tíras* "corn", *sávta* "grandma", *sáxbak* "friend"). The mora is thus not relevant for Hebrew, and the Minimal Word is thus analyzed under the syllabic level.

The effect of the Minimal Word as the minimal and maximal bound is manifested in Hebrew denominative verbs (Bolozky 1978; McCarthy 1984; Bat-El 1994; Ussishkin 1999, 2000). A denominative verb is disyllabic, regardless of whether its base is monosyllabic (e.g., *kod* "code" → *kidéd* "to codify"), disyllabic (e.g., *sabón* "soap" → *sibén* "to soap"), or trisyllabic (e.g., *télefon* "telephone" → *tilfén* "to phone").

It has been argued that this effect extends to the inflectional paradigms of verbs, where suffixation triggers prosodic alternation in the paradigm (Bat-El 1998; Ussishkin 2000; Graf & Ussishkin 2003; see, however, Bat-El this volume for an alternative account). The prosodic alternation involves deletion of the vowel in the stem final syllable when the suffix is vowel initial. The resulting prosodic structure is a disyllabic verb (2a), or a trisyllabic verb in cases where the disyllabic stem is accompanied by a derivational prefix (2b). In both cases, stress is final.

(2) **Table 1.** Vowel deletion

a. Disyllabic base

i. Past tense

Base	**Inflected forms**		
3rd MS SG	3rd FM SG *-a*	3rd PL *-u*	
ka.táv	kat.vá	kat.vú	"to write"
xi.pés	xip.sá	xip.sú	"to search"

ii. Participle[3]

Base	**Inflected forms**		
MS SG	MS PL *-im*	FM PL *-ot*	
KO.tév	kot.vím	kot.vót	"to write"
no.fél	nof.lím	nof.lót	"to fall"

b. Trisyllabic base (disyllabic stem):

i. Past tense

Base	**Inflected forms**		
3rd MS SG	3rd FM SG *-a*	3rd PL *-u*	
it.la.béʃ	it.lab.ʃá	it.lab.ʃú	"to dress"
it.ra.xéʦ	it.rax.ʦá	it.rax.ʦú	"to wash"

ii. Participle

Base	**Inflected forms**		
MS SG	MS PL *-im*	FM PL *-ot*	
mit.la.béʃ	mit.lab.ʃím	mit.lab.ʃót	"to dress"
mit.ra.xéc	mit.rax.ʦím	mit.rax.ʦót	"to wash"

3. Participles in Hebrew can function as verbs, nouns, or adjectives. Bat-El (this volume) argues that participles behave like adjectives, rather than verbs, with respect to V–Ø alternation. Children, however, use participles as verbs. According to Berman (1993), the first verbs take the form of infinitive, imperative, past, or present, where the past form is selected for telic achievements and the present for atelic activities.

Note that vowel deletion allows the prosodic structure of the inflected form to be identical to that of the base in terms of the number of syllables and stress. In all the above forms, stress is final; it falls on the stem's final syllable in the bare stem (e.g., *xipés* "he searched") and on the suffix in the inflected forms (e.g., *xips-á* "she searched"). Thus, vowel deletion could be due to the Minimal Word, but also to a requirement that all forms in the paradigm consist of the same number of syllables (Bat-El this volume).

Vowel deletion is blocked when it would otherwise yield a cluster of three consonants, i.e., a complex onset or a complex coda. There are two such cases: when the suffix is consonant initial (3a), and when the penultimate syllable in the stem is CVC (3b). In these cases, the suffixed form has an additional syllable. As for stress, in some cases, it stays on the stem final syllable (3b-i) and in others, it shifts to the suffix (3b-ii).

(3) **Table 2.** No vowel deletion

a. Inflected forms (Past) with a consonant-initial suffix

Base	**Inflected forms**			
3rd MS SG	1st SG *-ti*	1st PL *-nu*	2nd MS SG *-ta*	
ka.táv	ka.táv.ti	ka.táv.nu	ka.táv.ta	"to write"
xi.pés	xi.pás.ti[4]	xi.pás.nu	xi.pás.ta	"to search"

b. Inflected forms (Past) with a penultimate CVC syllable in the stem

i. Penultimate stress

Base	**Inflected forms**		
3rd MS SG	3rd FM SG *-a*	3rd PL *-u*	
id.lík	id.lí.ka	id.lí.ku	"to light"
ig.díl	ig.dí.la	ig.dí.lu	"to enlarge"

ii. Final stress

Base	**Inflected forms**		
3rd MS SG	3rd FM SG *-a*	3rd PL *-u*	
til.fén	til.fe.ná	til.fe.nú	"to phone"
nix.nás	nix.ne.sá	nix.ne.sú	"to roll"

There is one case where vowel deletion is lexically blocked, i.e., without any synchronic phonological motivation. This lexical idiosyncrasy is associated with the feminine suffix *-et*, which attaches to participles. Although it is vowel initial and its stem does not have a penultimate CVC syllable, there is no vowel deletion and stress stays on the stem.

(4) **Table 3.** Participle verbs with *-et*: penultimate stress and no vowel deletion

Base	**Inflected form**	
MS SG	FM SG *-et*	
no.fél	no.fé.let	"to fall"
me.xa.pés	me.xa.pé.set	"to search"

To summarize, the Minimal Word affects both stems and suffixed forms, as most stems and many suffixed forms are disyllabic (2). Stress in these cases is final. Under certain circumstances, the inflected suffixed forms may consist of more than two syllables ((3) and (4)), in which case stress is either final or penultimate.

As we show in the following section, there is a stage in the acquisition of Hebrew that has the same prosodic characteristics as those of the verb paradigm: maximal bound of two syllables and final or penultimate stress. This stage is called, not surprisingly, the Minimal Word stage (Demuth 1995).

3. The acquisition of Hebrew prosodic structure

The Minimal Word has been recognized as a stage in various studies of language acquisition. Fikkert (1994); Demuth (1995) & Demuth & Fee (1995), among others, show that during this stage, the binary foot, either moraic or syllabic, is the minimal and maximal bound of the prosodic word produced by children acquiring Dutch and English. Moreover, in accordance with the stress system of these languages, the foot is trochaic, i.e., stress is penultimate in disyllabic words. While in Dutch and English foot binarity is achieved either on the moraic or the syllabic level, in Hebrew, as noted above, the foot is binary only under a syllabic analysis.

Children acquiring Hebrew also exhibit the Minimal Word stage. As reported in Ben-David's (2001) longitudinal study, this stage lasts for a relatively long period, compared to other stages in the course of acquisition.[5] During this stage, the children's words are maximally disyllabic; polysyllabic target words are disyllabic (e.g., *pipó* for *cipór* "bird", *táta* for *sávta* "grandmother", *uká* for *metuká* "sweet FM", *téti* for *spagéti* "spaghetti") and monosyllabic target words remain monosyllabic (e.g., *dan* for *gan* "garden", *ta* for *kar* "cold").

4. As we are concerned with prosodic structure only, we ignore alternation in the vowel quality.

5. The relative long period of the Minimal Word stage could be attributed to the high type frequency of disyllabic words in Hebrew. However, a comparative cross-linguistic study should be done in order to verify this hypothesis.

As for stress, there is a disagreement with regard to the dominant foot type appearing in early speech. Some argue that it is deduced from the frequency of a particular foot type in the ambient language and/or from the stress system of the language (Demuth 1996; Tzakosta 2004). Others argue for the effect of universal grammar (Allan & Hawkins 1978; Rose 2000; Adam & Bat-El 2007a).

Stress in Hebrew nouns is lexical to a great extent (Bat-El 1993), since, as noted earlier, some nouns bear final stress, others penultimate, and a few antepenultimate, regardless of their syllabic structure (Graf 1999). In terms of frequency, final stress is dominant (Adam & Bat-El 2007a).

Children acquiring Hebrew hardly ever make stress errors at the stage under discussion here, i.e., before the paradigms of both verbs and nouns are produced (Ben-David 2001).[6] Ben-David & Berman (2007) report that out of thousands of productions obtained in Ben-David's (2001) longitudinal study, only 12 exhibited stress errors, without any specific direction (i.e., target words with penultimate stress were produced with final stress and vice versa). As claimed in Ben-David (2001), the negligible number of stress errors suggests that at this stage, the children do not have a cue to determine the prominent stress pattern, given the contradicting data, and thus exhibit a rote learning of the position of stress.

The Hebrew data thus offer an interesting example for the first prosodic shape in a language, which does not provide the children with a clear predominant stress pattern. In the absence of evidence from the ambient language, we expect the children to resort to universal markedness, i.e., to the unmarked foot. The unmarked foot in a quantity insensitive language like Hebrew is trochaic (Hayes 1995), and indeed, this is the first foot that emerges in the children's speech. Evidence is drawn from the progressive development of target words with final vs. penultimate stress. Disyllabic words corresponding to target words with penultimate stress (e.g., *kádo* for *avokádo* "avocado") appear in the children's speech before disyllabic words corresponding to target words with final stress (e.g., *virón* for *avirón* "airplane"). That is, at the stage where *avokádo* "avocado" is already produced as *kádo*, *avirón* "airplane" is still produced as *rón*/*ón*. Thus, the unmarked binary trochaic foot ([σσ]) is produced before iambic feet ([σσ́]). This qualitative evidence is further supported in Adam and Bat-El's (2007a) quantitative study.

6. Stress errors in nouns (but never in verbs) turn up only when suffixes start appearing (Berman 1980, 1981; Levy 1981, 1983). Initially, the children may preserve the stress on the stem rather than shift it to the suffix, e.g., *yéled* – **yéladim* (for *yeládim*) "children", *mirpéset* – **mirpésetim* (for *mirpasót*) "veranda".

In (5) below, we present the sub-stages of the Minimal Word proposed in Adam (2002), based on the acquisition of Hebrew nouns (see Adam 2002 for earlier and later stages):

(5) **Table 4.** The sub-stages of the Minimal Word stage[7]

a. Sub-stage 1

Target: [… σσ́] – production [σ́]; Target [… σ́σ] – production [σ́σ]

Child's word		Target word		
dúr	1σ	ka.dúr	2σ	"ball"
fé.fe	2σ	sé.fer		"book"
ón	1σ	a.vi.rón	3σ	"airplane"
é.et	2σ	ʃar.ʃé.ret		"necklace"
ká.do	2σ	a.vo.ká.do	4σ	"avocado"

b. Sub-stage 2

Target: [… σσ́] – production [σ́]~[σσ́]; Target [… σ́σ] – production [σ́σ]

Child's word		Target word		
dúr ~ a.dúr	1 ~ 2σ	ka.dúr	2σ	"ball"
fé.fe	2σ	sé.fer		"book"
rón ~ vi.rón	1 ~ 2σ	a.vi.rón	3σ	"airplane"
ʃé.ʃet	2σ	ʃar.ʃé.ret		"necklace"
ká.do	2σ	a.vo.ká.do	4σ	"avocado"

c. Sub-stage 3

Target: [… σσ́] – production [σσ́]; Target [… σ́σ] – production [σ́σ]

Child's word		Target word		
a.dúr	2σ	ka.dúr	2σ	"ball"
fé.fe	2σ	sé.fer		"book"
vi.rón	2σ	a.vi.rón	3σ	"airplane"
ʃé.ret	2σ	ʃar.ʃé.ret		"necklace"
ká.do	2σ	a.vo.ká.do	4σ	"avocado"

The data in (5a–c) show consistency in the number of syllables, as all productions are restricted to maximally disyllabic words, regardless of the number of syllables in the target words (recall, though, that monosyllabic target words remain monosyllabic in the child's productions). The difference between (5a) and (5b–c)

7. We suppress most of the errors in segments and syllable structure, as the acquisition of the prosodic word is our main issue.

has to do with the stress pattern: in sub-stage 1 (5a), all disyllabic words productions bare penultimate stress, whereas later on, in sub-stages 2 and 3 (5b–c), there are also disyllabic words with final stress. That is, the universally unmarked trochaic foot (penultimate stress), expected in a quantity insensitive language, is produced before the iambic foot (ultimate stress).

The earlier emergence of the trochaic foot correlates with findings reported in earlier studies, that children first produce the stressed and/or final syllables of the target form (Smith 1973; Echols & Newport 1992, among others). However, given the precedence of the trochaic foot, the Hebrew-speaking children produce both the stressed and final syllable, resulting in disyllabic words for target words with penultimate stress (e.g., *kádo* for *avokádo* "avocado") and monosyllabic words for target words with final stress (e.g., *ón* for *avirón* "airplane").[8] Later on, as shown in (5c), the children also produce the penultimate unstressed syllable, thus allowing target words with penultimate and final stress to be disyllabic (e.g., *virón* for *avirón* "airplane"). The transition between these two sub-stages (5c) exhibits variation in the number of syllables of target words with final stress (e.g., *ón* ~ *virón* for *avirón* "airplane").

Within the framework of Optimality Theory (OT; Prince & Smolensky 1993), this acquisition path is expressed by the interaction among constraints relating to the number of syllables and stress (see Demuth 1995; Pater 1997; and Adam 2002, among others).

(6) The active constraints in the acquisition of Hebrew prosodic words
  a. Markedness constraints
    i. PrWd=2σ[9]
      A prosodic word is disyllabic
    ii. Leftmost
      The stressed syllable is leftmost in the prosodic word
  b. Faithfulness constraints
    i. Faithσ́
      The stressed syllable in the input is present and stressed in the output (child's production)
    ii. AnchorR
      A syllable at the right edge of the input has a correspondent at the right edge of the output (child's production)

8. Prior to the Minimal Word stage, the children produce monosyllabic words, which usually correspond to the final or stressed syllable in the target word. However, at the very initial stage, segmental markedness also plays a role in the selection of the syllable (Adam 2002; Tubul-Lavy 2005; Adi-Bensaid 2006; Adam & Bat-El 2007b).

9. PrWd=2σ is a short hand for several markedness constraints which will not concern us here. See McCarthy & Prince (1993a,b) for original definition, and Ussishkin (2000) and Adam (2002) for application to Hebrew verbal system.

We assume that the child's input is identical to the target word until he starts acquiring the paradigm and establishes an input, which is often identical to one of the forms in the paradigm (see §4.2). The tableaux in (7) demonstrate the selection of the optimal candidates in sub-stage 1 (5a). Max, which prohibits deletion, is ignored due to its low ranking. Dep, which prohibits insertion, must be ranked above PrWd=2σ, in order to block insertion of a syllable in monosyllabic target words.

(7) Constraint interaction in the first sub-stage of the Minimal Word stage (5a)

a. Target (input) $\sigma_1\acute{\sigma}_2\sigma_3$ – Production (output) $\acute{\sigma}_2\sigma_3$

		faithfulness		markedness	
Input: ʃar.ʃé.ret		Faithσ́	AnchorR	Leftmost	PrWd=2σ
a.	ʃar.ʃé.ret			*!	*
b.	ʃé		*!		*
c.	rét	*!			*
d.	ʃár.ʃe	*!	*		
e. ☞	ʃé.ret				

b. Target (input) $\sigma_1\sigma_2\acute{\sigma}_3$ – Production (output) $\acute{\sigma}_3$

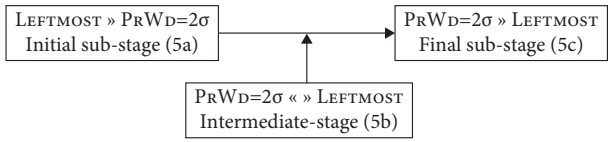
		faithfulness		markedness	
Input: avirón		Faithσ́	AnchorR	Leftmost	PrWd=2σ
a.	a.vi.rón			*!*	*
b.	ví.ron	*!			
c.	á.vi	*!	*		
d.	vi.rón			*!	
e. ☞	rón				*

The ranking of the markedness constraints, Leftmost (6a-ii) » PrWd=2σ (6a-i), is supported by the selection of *rón* (cand-e) rather than *virón* (cand-d) in (7b). The optimal candidates in both (7a) and (7b) suggest that Max (not given in the tableaux), which prohibits deletion, is low ranked. There is no evidence for the ranking among the faithfulness constraints, but the ranking faithfulness » markedness is supported in (7b) by the selection of *rón* (cand-e) rather than *ávi* (cand-c) or *víron* (cand-b); the latter two violate one or both of the higher-ranked faithfulness constraints, and are thus ruled out, allowing *rón* to be selected although it violates the markedness constraint PrWd=2σ.

The transition from this sub-stage to the following one is expressed by constraint reranking (Tesar & Smolensky 1993, 1998; Demuth 1995), whereby Leftmost is demoted below PrWd=2σ. Since the transition is gradual, it involves an

intermediate stage of variation (5b), consisting of the preceding (5a) and the subsequent (5c) sub-stages. However, only forms with final stress are in free variation (e.g., *rón* ~ *virón* for *avirón* "airplane"), since those with penultimate stress obey LEFTMOST in either case.

(8) Transition within the Minimal Word stage



During the intermediate sub-stage, the constraints PRWD=2σ and LEFTMOST are unranked, i.e., freely ranked with respect to each other (marked with '« »'in (8), and with a broken line in (9)), which means that the two opposite rankings are available, PRWD=2σ » LEFTMOST and LEFTMOST » PRWD=2σ. Thus, as shown in (9) below, forms of both the initial and the final stage are produced.

(9) Variable forms during transition – Intermediate sub-stage (5b):
Target (input) $\sigma_1\sigma_2\acute{\sigma}_3$ – Production (output) $\acute{\sigma}_3$ ~ $\sigma_2\acute{\sigma}_3$

		FAITHFULNESS		MARKEDNESS	
Input: avirón		FAITHσ́	ANCHOR-R	LEFTMOST	PRWD=2σ
a. ☞	rón				*
b. ☞	vi.rón			*	
c.	a.vi.rón			*	*!

At the last sub-stage of the Minimal Word (5c), LEFTMOST is safely positioned below PRWD=2σ, and therefore all words are disyllabic regardless of the position of stress. The faithfulness constraints still do the work of selecting the final and stressed syllable from the target word.

(10) Constraint interaction in the last sub-stage of the Minimal Word stage (5c):
a. Target (input) $\sigma_1\acute{\sigma}_2\sigma_3$ – Production (output) $\acute{\sigma}_2\sigma_3$

		FAITHFULNESS		MARKEDNESS	
Input: ʃarʃéret		FAITHσ́	ANCHORR	PRWD=2σ	LEFTMOST
a.	ʃar.ʃé.ret			*!	*
b.	ʃe.rét	*!			*
c. ☞	ʃé.ret				

b. Target (input) $\sigma_1\sigma_2\acute{\sigma}_3$ – Production (output) $\sigma_2\acute{\sigma}_3$

		FAITHFULNESS		MARKEDNESS	
Input: avirón		FAITHσ́	ANCHORR	PRWD=2σ	LEFTMOST
a.	a.vi.rón			*!	**
b. ☞	vi.rón[10]				*
c.	rón			*	

At this final sub-stage of the Minimal Word stage, the phonology of the children allows them to produce words with a maximum of two syllables, but with both final and penultimate stress.

Crucial for the ensuing discussion is the similarity between the prosodic restrictions active in this stage of acquisition, i.e., the disyllabic maximum with final or penultimate stress, and the prosodic restrictions active in the Hebrew verb paradigm. Recall from §1, that stress in Hebrew verbs is either final (in stems and suffixed forms) or penultimate (in suffixed forms). That is, the inflectional suffixes are either stressed (e.g., *sipr-á* "she told"), or preceded by a stressed syllable (e.g., *sipár-ti* "I told"). The phonology of the children given in (10) predicts *siprá* for *siprá* (cf. nouns – *virón* for *avirón* (10b)) and *párti* for *sipárti* (cf. nouns – *ʃéret* for *ʃarʃéret* in (10a)). However, this is not the case.

4. The puzzle

In §2, we showed that during the Minimal Word stage, children produce disyllabic nouns with penultimate and final stress, where the produced syllables correspond to the final and penultimate syllables in the target words. In §1, we showed that in suffixed verbs, stress falls on the suffix (ultimate) or on the syllable preceding the suffix (penultimate). Based on these prosodic considerations, we expect that during the Minimal Word stage, children will produce suffixed verbs (e.g., *márti* for *gamár-ti* "I finished" and *lá* ~ *naflá* for *nafl-á* "she fell"). This prediction is further enhanced by the type-frequency of suffixed verbs in the language; the categories

10. This constraint ranking will also select *arón* as the optimal candidate of the input *aviron*. The difference between *virón* and *arón* is in the selection of the unstressed syllable; in *virón* the penultimate target syllable is produced, and in *arón*, which violates CONTIGUITY, the antepenultimate target syllable is produced. We did not find a form like *arón* in our corpora, but we expect it to arise for segmental reasons, i.e., when the penultimate syllable consists of highly marked segments compared to those in the antepenultimate syllable (Adi-Bensaid 2006; Adam & Bat-El 2007b). However, for the issue under consideration here, both *virón* and *arón* fit the analysis, since their prosodic structure is identical in terms of stress and syllabic structure.

relevant for our discussion, past, participle, imperative and infinitive, consist of 18 types of forms out of which only 4 (22.2%) are without suffixes.[11]

Against the predictions established on the basis of the acquisition of nouns, Berman & Armon-Lotem (1997) and Armon-Lotem and Berman (2003) report that during the one-word stage, children tend to produce suffixless verbs, or what they call stem-like verbs. The data reveal that almost 100% of the verbs produced by 5 out of the 6 children reported in the study were without a suffix.[12] These figures were further supported by those in Adam (2003), who reports that YO also had produced almost 100% suffixless verbs up to the age of 2: 02. Below are some examples.

(11) **Table 5.** First verbs production[13]

Child's word	Target word		Age
1. fóx	la.a.fóx	"to turn over"	SM (girl) 1;6–1;7
	ta.a.fóx	"turn over! MS.SG"	
2. fál	na.fál	"he fell"	
3. xél	o.xél	"he is eating"	
4. tó.ax	lif.tó.ax	"to open"	
5. ni.gór	nis.gór	"we'll close"	
6. a.lá	a.láx	"he went"	
7. xék	le.sa.xék	"to play"	LI (girl) 1;5–1;6
	me.sa.xék	"he is playing"	
	si.xék	"he played"	
8. gór	lis.gór	"to close"	
9. ʃón	li.ʃón	"to sleep"	
10. pés	le.ta.pés	"to climb"	
	me.ta.pés	"he is climbing"	
	ti.pés	"he climbed"	
11. ni.gá	nig.már	"it is/was finished"	
	le.ʧa.yér	"to draw"	
	me.ʧa.yér	"he is drawing"	
12. se.yé	ʧi.yér	"he drew"	

11. The suffixes are as follows: Past Singular: 1st *-ti*, 2nd FM *-t*, 2nd MS *-ta*, 3rd FM *-a*; Past Plural: 1st *-nu*, 2nd *-tem*, 3rd *-u*. Participle Singular: FM *-a*/*-et*; Participle Plural: FM *-ot*, MS *-im*. Unsuffixed forms: Past and Participle MS SG, infinitive, and imperative.

12. We exclude here one bilingual child (SH), who exhibited a relatively large number of suffixed verbs, most of which were feminine suffixes in the imperative form (13 by SH vs. 0–4 by the other children). However, it should be emphasized that even when taking SH into account, the percentage of suffixed forms in this study do not exceed 25%

13. The underlined segmental material indicates an inflectional prefix: *l*(*V*)- for infinitive, *m*(*V*)- for participle, and *t*(*V*)- for 2nd person masculine imperative.

13. táx	nif.táx	"it is/was opened"	LE (boy) 1;9–1;10
14. mi.már	nig.már	"it is/was finished"	
	le.o.ʧí	"to take out"	
15. o.sí	o.ʧí	"he took out"	
	mo.ʧí	"he takes out"	
16. gór	lis.gór	"to close"	
17. go ~ i.gó	lis.gór	"to close"	YO (boy) 1;10–2;2
18. táx ~ i.táx	nif.táx	"it is/was opened"	
19. sí(k)	maf.sík	"he stops"	
	taf.sík	"stop! MS.SG"	
	le.af.sík	"to stop"	
20. dí(k) ~ a.dí(k)	mad.lík	"he is lighting"	
	le.ad.lík	"to light"	
	id.lík	"he lit"	
21. pax ~ i.páx	niʃ.páx	"it is/was spilt"	
22. la ~ a.lá	a.láx	"he went"	

Morphologically, all the children's verbs in (11) above match target verbs without a suffix. Prosodically, the verbs are consistent with the Minimal Word stage discussed in §2; that is, disyllabic words with final stress (e.g., *nigá* for *nigmár* "it is/was finished") are found alongside disyllabic words with penultimate stress (e.g., *óax* for *liftóax* "to open") and monosyllabic words corresponding to target words with final stress (e.g., *xék* for *lesaxék* "to play").

Insofar as the prosodic development and the type-frequency of the suffixed forms in the target paradigms are concerned, the children should be able to produce suffixed forms. For example, at this stage, they should have produced the verb *axá* for *alx-á* "she went" (cf. *aláx* "he went") as they have no problem producing the noun *adá* for *yaldá* "girl". Similarly, they should have produced the verb *nánu* for *igá-nu* "we arrived" because they do produce the noun *nína* for *plastalína* "plasticine". Based on the constraint ranking proposed in §2 for the Minimal Word stage, the tableaux below demonstrate the expected, but nevertheless unrealized, outputs of the verbs *nafl-á* "she fell" (11a) and *nafál-ti* "I fell" (12b).

(12) The expected verb forms during the Minimal Word stage (cf. (8b)):

a. Target (input) $\sigma_1\acute{\sigma}_2$ – Production (output) $\acute{\sigma} \sim \sigma_1\acute{\sigma}_2$

Input: naflá	FAITHFULNESS		MARKEDNESS	
	FAITHσ́	ANCHORR	LEFTMOST	PRWD=2σ
a. lá				*
b. ☞ naflá			*	
c. ☞ nafál	*!	*	*	

b. Child's input (= target): $\sigma_1\acute{\sigma}_2\sigma_3$ Child's output: $\acute{\sigma}_2\sigma_3$

	FAITHFULNESS		MARKEDNESS	
Input: nafálti	FAITHσ́	ANCHORR	LEFTMOST	PRWD=2σ
a. fál		*!		*
b. na.fál			*!	
c. ☞ fál.ti				
d. na.fál.ti				*!

According to (12a), both *lá* (cand-a) and *naflá* (cand-b) are expected to surface during the Minimal Word stage for the input *naflá*. Both, however, are rarely produced at this stage. Rather, most of the children's verb forms at this stage are stems, in this case *fál* ~ *nafál*. Similarly, in (12b), the optimal candidate *fálti* (cand-c) is a form that rarely appears in this stage. In this case too, all that the child produces are the syllables pertaining to the stem, i.e., *fál* ~ *nafál*.[14]

The few suffixed forms that children do produce are rote-learned unanalyzed forms (MacWinney 1978; Berman 1980, 1982, 1985, 1986; Kaplan 1983; and Dromi 1987). That is, the use of suffixes is not productive, and the suffixed forms are not members of a morphological paradigm in the child's speech. For example, a child that produces *áfa* "she flew", where the final *a* is the feminine suffix, does not produce any other morphological form of this verb (e.g., *af* "he flew", or *áfu* "they flew"). The question is then why there are so few rote-learned verbs with suffixes, given that, as argued above, there are no prosodic restrictions that block their production?

Since the children's productions do not exhibit an inflectional paradigm, we could say that the absence of suffixed verbs is due to the absence of morphological knowledge. However, if they have not yet acquired morphological knowledge, they should be indifferent to the difference between suffixed and unsuffixed verbs, and thus produce them both with a similar degree of frequency (actually, if frequency plays a role, we expect more suffixed forms).

We thus propose in the ensuing discussion that at the Minimal Word stage, the children already have morphological knowledge. This knowledge enables them to identify the stem and thus distinguish between stems and inflectional suffixes. However, due to the interaction between morphological and phonological constraints at this stage, the children are not yet able to exhibit the inflectional paradigm in their speech.

14. Actually, we expect the form *fáti* for *nafálti* "I fell", since the children do not have a medial coda at this stage (Ben-David 2001). However, we are concerned here with the prosodic word, i.e., number of syllables and stress, rather than syllable structure, and therefore ignore this discrepancy.

5. Morphological development

The explicit reference to the stem on the one hand and the absence of inflectional paradigm on the other, allow us to explore two issues: (a) the phonology-morphology interface at the Minimal Word stage (where phonology here refers only to the prosodic word), and (b) the lexical representation of inflected verbs in early acquisition. Before raising these issues, we introduce the morphological model we adopt.

5.1 Affixes as constraints

The morphological model adopted in this study is the Item-and-Process model (Hockett 1954; Aronoff 1976; Kiparsky 1982; Anderson 1992), which contrasts with the Item-and-Arrangement model (Selkirk 1983; Lieber 1992). Within a rule-based approach, the Item-and-Process model views affixation as a process, where affixes are part of the morphological rule that attaches them. The Item-and-Arrangement model views affixes as a lexical item presented along with the stem. One of the significant advantages of Item-and-Process over Item-and-Arrangement for the current discussion is that the former enhances the difference in the status of stems and affixes in the grammar (see Anderson 1992 for further considerations).

In most studies within the framework of OT, there is no clear distinction between the two approaches, since the suffixes appear in the input as well as in alignment constraints that state their position with respect to the stem. However, in several recent works, the Item-and-Process model has been considered within the framework of OT as a distinctive and preferred approach for capturing representations and processes in both phonology and morphology (see Russell 1995, 1999; as well as Yip 1995; Hammond 2000; Bat-El 2001, 2003b). Some of these studies (Russell & Hammond) have taken the Item-and-Process a bit further, arguing that all morphemes, i.e., stems and affixes, are constraints. We assume, however, as in pre-OT model, that only processes are represented as constraints, i.e., affixes but not stems. This approach reflects the phonology-morphology interface via the same OT mechanism that accounts for all aspects of grammar, i.e., constraint interaction.

Within this model, morphological constraints are inherently anti-faithful (Alderete 2001; Bat-El 2003b), reflecting the role of morphology in creating contrast among lexical categories. Given the stem as the input, the morphological constraints require the output to be phonologically different from the input, either by the addition of an affix or by some phonological process (e.g., ablaut). Note that the notion of *anti*-faithfulness significantly differs from that of *un*faithfulness. The former is a consequence of a direct requirement for morphological contrast, while the latter is a consequence of ranking faithfulness constraints below markedness constraints, through which a contrast is neutralized.

The attachment of an inflectional suffix to a verb stem, which is our main concern here, is, in fact, a morpho-syntactic requirement, while the structure of the output is a consequence of morpho-phonological requirements. Following Adam & Bat-El (2000), the principles of affixation within the Item-and-Process model of OT are as follows:

(13) Principles of affixation within the Item-and-Process model of OT
   a. The input consists of the stem and the required morphological category
      e.g., *nafal*[Past FM.SG]
   b. The suffix is represented by an alignment constraint which
      i. "aligns" the suffix to the appropriate edge of the stem, and
      ii. "matches" its morphological category to that required by the input.

We assume, with Scobbie et al. (1996), that there is no distinction between structure building and structure checking. Therefore, an alignment constraint not only checks whether the affix is in its designated position (checking) but also requires the affix to be surface true (building).

The schema of the affixation constraints is given below:

(14) Affixation constraint
   A&M[AFFIX]CAT
   Align&Match ($Affix_{Cat}$, L/R, $Stem_{Cat}$, R/L)
   (Align the left/right edge of an affix with the right/left edge of a stem, and match the category of the affix with that required by the stem)

Such a constraint can be violated in two different cases: (a) when an affix specified in the constraint does not appear in the output, and (b) when the category of the affix in the output does not match the category specified in the input (we ignore here possible segmental mismatch).

When a suffix is attached to an input stem, the right edge of the output does not correspond to the right edge of the input, because the input is the stem alone. In §2 we used ANCHORR (6b) to express input-output correspondence at the right edge of the prosodic word. This constraint conflicts with A&M[SUFF] (14), which adds segmental material at the right edge. Thus, in order to allow the suffix to be surface true, ANCHORR has to be ranked below A&M[SUFF], as demonstrated in the tableau below:

(15) Suffixation in adult grammar: Input: *nafál*[Past 1SG] – Target *nafálti*

Input: nafal [Past 1SG]	MORPHOLOGICAL	FAITHFULNESS
	A&M[-ti]$_{[Past\ 1SG]}$	**ANCHORR**
a. nafál	*!	
b. ☞ nafálti		*

Candidate (a), which is faithful to the input (i.e., the stem), is ruled out by the dominant morphological constraint, since it does not include the required suffix. Candidate (b) is optimal, although it violates ANCHORR, since this faithfulness constraint is ranked below the morphological constraint, which requires the suffix to surface.

Given this model, the absence of inflectional suffixes in children's productions can be understood as the consequence of an initial ranking in which the morphological constraints referring to the suffixes are ranked below the phonological faithfulness constraint ANCHORR.

5.2 The emergence of morphological knowledge

As emphasized above, the first verbs produced by children are morphologically suffixless (10), and prosodically match the Minimal Word stage. For ease of exposition, we refer here only to the final sub-stage of the Minimal Word stage, where words are maximally disyllabic with final or penultimate stress (i.e., PRWD=2σ » LEFTMOST).

In order to account for the fact that the children do not produce suffixed forms we make the following assumptions:

a. The child's input is not the suffixed form but rather the stem.
b. The morphological constraints assigning the inflectional suffixes, i.e., A&M[SUFF], are ranked below faithfulness constraints, in particular below ANCHORR.

This is demonstrated in the tableau in (16) for the inflected verb *nafálti* "I fell", whose stem is *nafál*.

(16) Target *nafálti* – Child's input (=stem): *nafál*[Past 1st. SG]

Input: nafál[Past 1SG]	PHONOLOGY			MORPHOLOGY
	FAITHFULNESS	MARKEDNESS		
	FAITHσ́ ANCHORR	PRWD=2σ	LEFTMOST	**A&M[-ti]$_{[Past\ 1SG]}$**
a. fál		*!		*
b. ☞ na.fál			*	*
c. na.fál.ti	*!	*	*	
d. fál.ti	*!			

The suffixed candidates (c) and (d) violate ANCHORR, which is ranked above the morphological constraint. The suffixless candidates (a) and (b), are both faithful to the input stem with respect to the relevant constraints, but at the final sub-stage of the Minimal Word, the ranking PRWD=2σ » LEFTMOST selects *na.fál* (cand-b) as the optimal candidate. Thus, during the first sub-stage, where LEFTMOST outranks PRWD=2σ, *fál* (cand-a) is the optimal form.

Note that the child's input is identical to that of the adult's, i.e., the stem.[15] Nevertheless, the child, unlike the adult, does not produce inflected forms because the morphological constraints attaching the suffixes are ranked below the phonological constraints responsible for the prosodic structure at this stage. This grammar predicts that the child's output would be the stem, regardless of the word he attempts to produce. Indeed, as noted by a reviewer, it is possible that the child does not attempt to produce an inflected form at this stage. While we cannot know which verb the child attempts to produce, the possibility that he does not attempt inflected verbs also supports our claim that the child identifies the stem.

Below is another example, demonstrating why the suffix *-a* cannot be included in the child's production at this stage.

In this tableau, the suffixed candidates (cand's-c, -d, -e) violate AnchorR as well as Faithσ́ (cand's-c, -e) and/or PrWd=2σ (cand's-c, -d). Notice that the candidate identical to the target form *naflá* (cand-e), violates Faithσ́, since the stressed vowel of the input stem is absent in the output. However, this form does not violate the markedness constraint PrWd=2σ.

The model presented above does not rule out rote-learned unanalyzed forms, i.e., it can account for the few suffixed forms that appeared in the children's speech. In such cases the input is not the stem but rather the unanalyzed suffixed form. Such a case is possible when the child has perceived only one form of the verb, which happens to be suffixed. The model thus distinguishes between productive suffixation, where a suffix is attached to a stem via a morphological constraint, and rote-learned suffixation, where a suffix appears unproductively as a consequence of encoding the inflected target form as the input.

(17) Target *naflá* – Child's input (= stem): *nafál*[Past 3fm.sg]

Input: nafál [Past 3fm.sg]		phonology				morphology
		faithfulness		markedness		
		Faithσ́	AnchorR	PrWd=2σ	Leftmost	A&M[-a]$_{[Past\ 3fm.sg]}$
a.	fál			*!		*
b. ☞	na.fál				*	*
c.	na.fa.lá	*!	*	*	**	
d.	na.fá.la		*!	*	*	
e.	naf.lá	*!	*		*	

15. In the adult's grammar, the stress on the stem is regular, thus does not need to be specified in the input (see Graf & Ussishkin 2003 for the verbal stress system). Given that only stems appear at this stage of the acquisition of verbs, we cannot tell whether the children have already acquired the verbal stress system. We thus assume that like in nouns (see §2), they take the adult's surface stem as an input (i.e., the 3rd person masculine), which includes stress.

(18) Unanalyzed rote-learned suffixed forms: Input (= target) *naflá*

Input: naflá		phonology				morphology
		faithfulness		markedness		
		Faithσ́	AnchorR	PrWd=2σ	Leftmost	A&M[-a][P$_{ast\ 3}$fm.sg]
a.	fál	*!	*	*		*
b.	na.fál	*!	*		*	*
c.	nafalá			*!	**	
d.	nafála	*!		*	*	
e. ☞	naflá				*	

To conclude, the ranking phonology (faithfulness) » forphology, representing the initial state of the phonology-morphology interface, does not allow productive suffixes to be surface true, even though verbs with suffixes are prosodically possible. That is, the children have morphological knowledge of the verb paradigm, but this ranking does not allow them to manifest this knowledge in their speech. The rote-learned suffixed forms, for which the children have not yet acquired the paradigm, actually support this analysis. First, they show that verbs with suffixes are prosodically possible. Second, the fact that they are rare suggests the children have morphological knowledge with respect to most verbs.

In order for productive suffixes to surface in the children's speech, a reranking has to occur such that A&M[Suff] will be ranked above AnchorR. The morphological development thus involves the demotion of phonological faithfulness constraints below the morphological constraints.[16]

6. Conclusion

There is a vast amount of literature suggesting that perception precedes production, but most of these studies refer to phonology (e.g., Smith 1973; Locke 1983; Werker & Tees 1984, among others). Here we have shown that this is true for morphology as well. We argued that the absence of inflected (suffixed) verbs in the child language reflects the presence of morphological knowledge rather than its absence. That is, at least some aspects of the morphology have been encoded before the appearance of the paradigm in the child's speech.

A similar claim is presented in Demuth (1994), and Gerken (1996), among others, who argue that children show knowledge of function morphemes at the

16. Of course, not all suffixes appear at once (see Armon-Lotem 1997).

stage where they still do not produce them, or produce them variably. Gerken (1996) explains the absence of function morphemes by prosodic restrictions, which enforce deletion of weak (unstressed) syllables, which cannot be mapped into a trochaic foot. In our study, however, the phonology of the children (§2) actually predicts that the inflectional suffix will occur, as they are either stressed (e.g., *nafl<u>á</u>* 'she fell'), or preceded by a stressed syllable (e.g., *nafál<u>ti</u>* 'I fell').

Our model expresses the presence of morphological knowledge by positing the stem, rather than the target inflected verb in the child's input. That is, the child's lexical representation at this stage is identical to that of the adult's. The difference between the adult's and the child's grammar is thus not in the lexical representation but rather in the constraint ranking. While in the adult's grammar, the morphological constraints assigning the suffixes outrank the faithfulness constraint AnchorR, in the child's grammar, it is the other way around. It is thus the constraint interaction, faithfulness » morphology, that does not allow the suffixes to be surface true in the child's speech.

It is quite conceivable that initially, verbs are rote-learned. However, we found very little evidence for this stage in production (just a few rote-learned inflected verbs). It is possible that the perceptual capacity of children is quite developed at the stage where verbs enter their lexicon (after nouns). At the stage where the children manifest morphological knowledge, which was the main concern of this paper, the children must have perceived at least two forms for each verb stem. This allows them to identify the stem and posit it in their lexical representation. As argued, the presence of morphological knowledge does not imply the production of the paradigm. This appears in the subsequent stage, where the faithfulness constraint AnchorR is demoted below morphological constraints assigning the inflectional suffixes.

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