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PATHS AND STAGES IN THE ACQUISITION OF HEBREW PHONOLOGICAL WORD

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The acquisition of Hebrew phonology has started gaining attention during the last two decades, with quantitative and theoretical studies on the distribution and development of various phonological structures. In this paper, we follow the acquisition of the phonological word in Hebrew, attending to the prosodic word (number of syllables), the foot (stress patterns), the syllable and its sub-syllabic units (onset and coda), and the segments and their features. For each type of phonological structure, we (a) provide distributional facts in Hebrew, in order to evaluate the role of frequency in phonological development; (b) discuss the constraints active during the different stages of development; and (c) introduce the simplification strategies children employ on their way to faithful targets. At the end we consider the resources children use during their phonological development.

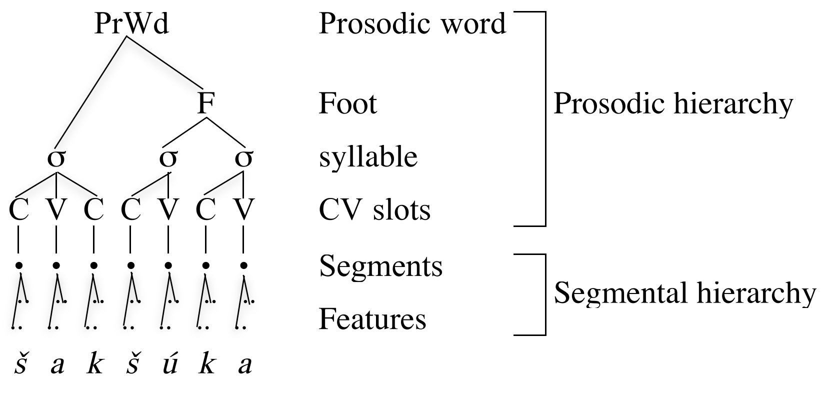
Key words: language acquisition, Hebrew, phonology, prosodic word, syllable, onset, coda, stress, trochaic bias, segments, features, frequency, nature vs. nurture.

1. Introduction

When we start studying children's language development, using phonetics as our data source, our first encounter with children's grammar lies within the domain of phonology, i.e. the mental system that categorizes and organizes the phonetics of speech. Data and generalizations are approached from two angles: (a) the principles active in the children's phonological system during every stage of development, and (b) the correspondence between the children's productions and the adults' targets.

With these two angles in mind, we follow landmarks in the acquisition of Hebrew phonological system, limiting ourselves to the phonological word (1), which consists of a prosodic hierarchy (Selkirk 1982, McCarthy and Prince 1986, Nespor and Vogel 1986) and a segmental hierarchy (Clements 1985, Clements and Hume 1995).

(1) The phonological word



Our paper proceeds top down on the hierarchical structure of the word, attending to (a) distributional facts in Hebrew nouns, based on Bolozky and Becker's (2010) lexicon of 12,043 Hebrew nouns; (b) the children's phonological system during each stage, and (c) the simplification strategies encountered in target-production correspondences.

We start with the stages in the acquisition of the prosodic word (§2) in terms of the number of syllables. We then attend to the foot (§3), a prosodic unit responsible for stress patterns, and discuss the evidence Hebrew provides for the trochaic bias. The discussion on the syllable (§4) concentrates on the stages of the acquisition of onsets and codas, with emphasis on simplification strategies. Finally, the order at which the segments appear in the children's speech is considered (§5), with reference to the position of the segments in the syllable/word and their features. We conclude with a brief discussion on the forces playing a role during phonological development (§6).

In several contexts throughout the paper we inquire into the role of universal markedness and language-specific effects in phonological development, an issue known as the nature-nurture debate. We use the terms *markedness* (Battistella 1996, de Lacy 2006, Rice 2007) with reference to universal typological preferences (nature) and refer to frequency when seeking for language-specific effects (nurture).

2. Prosodic Word

Hebrew-acquiring children are exposed to noun stems consisting of 1-4 syllables, though in different frequency (Cohen-Gross 1997). Most Hebrew nouns are disyllabic (47%), and many are trisyllabic ones (35%); nouns with more than three syllables are much less common (13%), and monosyllabic nouns are rare (5%). In verbs, the percentage of monosyllabic words is much lower, and there are no bare verb stems that exceed the disyllabic maximum. Similar distribution is found in Child Directed Speech (Segal et al. 2008), with 59% disyllabic words, 30% trisyllabic words and only 10% monosyllabic words.

The acquisition of Hebrew prosodic word follows four major stages (Ben-David 2001, Adam 2002), defined in (2) in terms of the number of syllables and with reference to the Minimal Word (MW). The MW is a phonological unit that delimits the size of a word to a binary foot, consisting of either two syllables or two moras (McCarthy and Prince 1986).[1] For example, the Amazonian language Cavineña (Guillaume 2008) adds a vowel to roots below the MW size (e.g. /kwa/ → *kwau* 'go', /he/ → *heu* 'come'), and many languages, including Hebrew (Bat-El 2005), truncate segmental material in order to reach the maximal size of the MW in hypocoristics (e.g. *cipóra* → *cípi*, *yisraéla* → *réli*). The MW plays a role in the Hebrew lexicon, where disyllabicity is the most prominent word size, as well as in Chinese, where 70% of the words are nowadays disyllabic (Duanmu 2007).

(2) Stages in the acquisition of the prosodic word[2]

	Stage	nešiká 'kiss'	lemáta 'up'	músika 'music'
a.	Sub-MW	ka	ma / ta	mu / ka
b.	Pre-MW	ka	máta	múka
c.	MW	šiká	máta	múka
d.	Post-MW	nešiká	lemáta	músika

2.1. Sub-MW stage: This stage is characterized with monosyllabic productions regardless of the size of the target word. Given the low frequency of monosyllabic words in Hebrew, the sub-MW stage is rather short, such that the first 10 words produced by typically-developing children already include disyllabic words (Ben-

[1] A mora is a sub-syllabic unit relevant to syllable weight. In Arabic, for example, syllables with long vowels (CV:) or codas (CVC) are heavy, consisting of two moras, while syllables with short vowels (CV) are light. Modern Hebrew phonology does not distinguish between short and long vowels or light and heavy syllables, and therefore the mora does not seem to be relevant.

[2] *y* = *j*, *c* = $\widehat{ts}$, *ǰ* = $\widehat{dʒ}$ and *š* = *ʃ*. Hebrew *r* is phonetically ʁ. Acute mark on a vowel indicates primary stress.

David 2001). In atypical development, however, this stage can prolong to a great extent (Adam and Bat-El 2008a).

In terms of target-production correspondence, during all stages children truncate syllables to reach the word size dominant during the relevant stage (3). The syllables surviving truncation, and thus produced by the children, are the final and the stressed ones, due to their acoustic salience (Echols and Newport 1996). In Hebrew, as in many other languages, vowels in stressed and phrase final syllables are phonetically longer, thus acoustically more accessible. When it comes to competition between these two, quantitative data suggest that final syllables have better chance to survive than stressed ones (Ben-David 2014a, Ben-David and Bat-El 2015). While stress and final position are the major factors in determining which syllable survives and which truncates, there is evidence from prolonged atypical development suggesting that segments, in particular vowels, may also play a role (Adam and Bat-El 2008a).

2.2. Pre-MW stage: The first disyllabic productions appearing in the children's speech are with penultimate stress, the universally preferred stress pattern (§3). Since children often preserve the stress pattern of the target word, targets with penultimate stress (e.g. *kélev* 'dog', *rakévet* 'train') are produced as disyllabic before targets with final stress (e.g. *xatúl* 'cat', *mataná* 'gift').

2.3. MW stage: This is the stage where target words with final stress are produced as disyllabic, since during this stage, the children's productions are of maximal size two syllables, regardless of the stress pattern. However, the MW at this stage is the maximal but not the minimal limit, since monosyllabic target words are produced as monosyllabic. An additional vowel, and thus a disyllabic word, may be produced for monosyllabic targets, but this is not due to the MW restriction but rather to cluster simplifications (§4.1.2).

2.4. Post-MW stage: During this stage, children add more and more syllables towards the target size. It is quite possible, though has not yet been studied yet, that the segments (and the syllable structure) play a role. Evidence for this would be obtained from words with four syllables, which are scarce in Hebrew, in particular in children's vocabulary. There is clear preference for acquiring the syllables at the order they appear in the target; e.g. *tína* ⇒ *mantína* ⇒ *klemantína* 'tangerine'. However, in target words like *marcipánim* 'marzipans', the expected syllable to be produced right after the MW is the segmentally marked syllable [*ci*], and thus the next in line less marked syllable [*ma*] may appear. That is, instead of the order-based development *pánim* ⇒ *cipánim* ⇒ *marcipánim* we may get the markedness-based development *pánim* ⇒ *mapánim* ⇒ *marcipánim.*

(3) Truncated forms

	Non-final stress			***Final stress***		
Stage	***Child***	***Target***	***gloss***	***Child***	***Target***	***gloss***
Sub-MW	ba	báit	'house'	ba	balón	'balloon'
	pa	taxpóset	'costume'	ta	tarnegól	'rooster'
	bu	ótobus	'bus'	ni	duvdevanim	'cherries'
Pre-MW	téfon	télefon	'telephone'	ba	bubá	'doll'
	téti	spagéti	'spaghetti'	ka	nešiká	'kiss'
	tína	klemantína	'tangerine'	tam	hipipotám	'hippopotamus
MW	fáfa	jiráfa	'giraffe'	apít	kapít	'tea spoon'
	kófe	kórenfleks	'cornflakes'	taté	matatté	'broom'
	kádo	avokádo	'avocado'	fefón	melafefón	'cucumber'
Post-MW	gagólet	tarnególet	'hen'	akiyá	xanukiyá	'Menorah'
	azíza	televízya	'television'	ulasím	mešulaším	'triangles'
	ikóter	elikópter	'helicopter'	adión	akordión	'accordion'

3. Stress Pattern

Stress in Hebrew is predominantly final, with about 70% final stress in Hebrew noun types (Adam and Bat-El 2009) and child directed speech (Segal et al. 2008). Following Graf and Ussishkin (2003), and the universal preference for binary feet (Prince 1980 and later studies), we assume a final iambic foot in words with final stress (e.g. *max[laká]* 'department'), a final trochaic foot in words with penultimate stress (e.g. *max[béret]* 'notebook'), and a non-final trochaic foot in words with penultimate stress (e.g. *[téle]fon* 'phon'). In the absence of acoustic evidence for secondary stress (Becker 2002), we assume a single foot for a phonological word; syllables outside this foot are unfooted (see the first syllable in (1)).

A controversial claim, known as the "trochaic bias" (Allen and Hawkins 1978), credits the children with an innate preference for the trochaic foot. However, evidence for the trochaic bias has been drawn mostly from languages where feet are predominantly trochaic (e.g. English, Dutch), and thus one cannot tell whether this preference is indeed innate (nature) or whether it reflects distributional frequency in the ambient language (nurture).

Hebrew, unlike other languages, provides strong support for the trochaic bias (Adam and Bat-El 2008a, 2009); although it is predominantly iambic, children show early preference for the trochaic foot. This preference is manifested in the children's productions and attempted targets. As noted above, there are more iambic than trochaic words in Hebrew (i.e. more word with final than with non-final stress), but nevertheless children attempt more trochaic words than iambic during early stages of acquisition, and also produce more trochaic words than iambic. The preference for trochee is manifested in the development of the prosodic word (§2), where disyllabic words with penultimate stress (trochaic) are produced before disyllabic words with final stress (iambic).

The most noticeable manifestation of this preference is truncation during the pre-MW stage, where children truncate targets with final stress to monosyllabics (e.g. *matanáá* → *ná* 'gift'), but produce disyllabic words with penultimate stress (e.g. *avokádo* → *ádo* 'avocado'). A case study reported in Adam and Bat-El (2008a, 2009) reveals 58% (91/156) attempted trochaic targets during the first three periods of lexical development (a lexicon of 150 words), 60% (84/141) trochaic production types, and 67% (225/335) trochaic production tokens. This is rather significant given the distribution in Hebrew, where about 70% of the nouns are iambic (and even more so are verbs).

Other phenomena supporting the trochaic bias, though less common, are word final vowel epenthesis and stress shift.

(4) Processes supporting the trochaic bias (in addition to truncation)

a. Vowel epenthesis

Child	***Target***	
náva	arnáv	'rabbit'
ogáwa	ogér	'hamster'
sagóla	sagól	'purple'
otúla	xatúl	'cat'
kadeíma	kadurím	'balls'

b. Stress shift

Child	***Target***	
sáov	caóv	'yellow'
búžit	xipušit	'beetle'
jíson	lišon	'to sleep'
kájef	lekaléf	'to peel'
avúna	afuná	'pea'

The data in (4) are drawn from a typically-developing girl (4 recording sessions, age 1:10;3-1;11.7), who had a clear preference for trochee, with 66% (140/213) tokens with penultimate stress out of all polysyllabic productions (Stern-Sabach 2013). Moreover, out of her monosyllabic tokens, 39% (44/112) corresponded to polysyllabic targets where all but two were with final stress (e.g. *yarók* → *ok* 'green', *xavitá* → *ta* 'omelet'). In order to obtain trochaic productions, the child not only selected trochaic words but also changed the target stress pattern to trochee in 28%

(39/140) of the trochaic productions. This was done mostly via epenthesis (n=35) and in a few others with stress shift (n=4).

The child displaying stress shift (4) had 160 production tokens (1 session age 2;0), out of which 69% (n=111) were trochaic, i.e. with non-final stress. He did not select a particularly large number of trochaic targets, as many children do; his targets were 60% (n=98) with final stress, 30% (n=43) with non-final stress, and 10% (n=19) monosyllabic. However, he employed a massive stress shift; out of the 98 targets with final stress, 69% (n=68) undergone stress shift to non-final stress and only 19% (n=19) preserved their final stress. Moreover, only targets with final stress were truncated to monosyllabic (11%; n=11).

These data support the universal trochaic bias (nature). As shown above, frequency in the ambient language cannot explain the preference for trochee in early acquisition of Hebrew (nurture), though one could argue that the acoustic prominence of the final and/or stressed syllables play a role here (nurture). However, stress shift from a target strong (final stressed) syllable to a weak one (4) cannot be attributed to accessibility; it must then be the universal trochaic bias (nature).

4. Syllable structure

The most frequent syllables in Hebrew are CV (47%) and CVC (40%), with significant difference between the two structures (p<.01), though in word final position CVC (63%) is more common than CV (30%). Syllables with complex onsets CCV(C) are rare (4%), appearing mostly in word initial position, and syllables with complex codas (C)VCC are even rarer (1%).[3] In this respect, Hebrew complies with cross-linguistic typological evidence for CV being the unmarked syllable.

Thus, the early preference of Hebrew-acquiring children for syllables with simple onsets (§4.1) and no codas (§4.2) follows both universal as well as language-specific markedness. However, as shown below, children's simplification strategies do not always conform to universal principles.

4.1. Onsets: 88% of the syllables in Hebrew have a simple onset (a single consonant), some (9%) are onsetless, and a few (4%) have a complex onset (two consonants).[4] Following universal and language specific preferences, children amend target complex onsets (§4.1.2). However, contrary to universal and language specific preferences, children do not amend onsetless syllables; on the contrary, in some cases they delete a target onset (§4.1.1).

4.1.1. Simple onsets: The first syllable produced by typically-developing children is CV, where the onset is simple, consisting of a single consonant (*ken* → *ke* 'yes', *yaldá* → *da* 'girl'). This complies with universal preferences as well as language-specific distribution.

However, for atypically developing children, the first syllable is quite often V, i.e. an onsetless syllable (e.g. *en* → *e* 'no more', *šaón* → *o* 'watch'). Given the mono- and disyllabic productions in early stages of acquisition (§2) and the late development of codas (§4.1.2), atypically-developing children may produce consonant-free words (Adi-Bensaid and Tubul-Lavy 2009); mostly monosyllabic, as found in hearing impaired children (Adi-Bensaid 2006), but also disyllabic, as found in children with developmental dyspraxia (Tubul-Lavy 2005). This leads to a pervasive loss of contrast in any language, let alone Hebrew (and other Semitic languages) where word classes (*binyanim* for verbs and *mishkalim* for nouns) are defined on the basis of their vocalic pattern and prosodic structure (Bat-El 2011). For example, the child's

[3] We thank Stav Klein for compiling these data from Bolozky and Becker's (2010) lexicon of 12,043 Hebrew nouns (total of 29,260 syllables) using Gafni's Child Phonology Analyzer (2014).

[4] Onsetless syllables correspond to syllables spelled with initial <*ʔ*, *ʕ*, *h*>, which rarely have a phonetic manifestation in casual speech.

production *aó* corresponds to many target adjectives, including *yarók* 'green', *kaxól* 'blue', *gadól* 'big', *aróx* 'long' and *matók* 'sweet'. Apparently, there are also a few consonant-free monosyllabic words in typical development, suggesting that this is a reminiscence of the pre-word babbling (Adi-Bensaid and Bat-El 2004).[5] The prolonged atypical development often provides a window to phenomena that are negligible or even unobservable in typical development.

In monosyllabic productions of typically developing children, a simple onset is always surface true, unless there is no such in the target (e.g. *af* 'nose'). In polysyllabic productions, however, the initial onset can be missing (e.g. *mitá → itá* 'bed', *dúbi → úbi* 'teddy bear', *tarnególet → agólet* 'hen'). Word initial onset deletion is not limited to particular segments or to a particular stress pattern, though Karni (2011, 2012) indicates a slight preference for deletion of sonorants compared to obstruents, and Ben-David (2001, 2010) shows preference for deletion in unstressed syllables. Word initial onset deletion, which can appear in up to 19% of the children's productions (Karni 2011, 2012) is theoretically puzzling since syllables with onsets are less marked and more frequent than syllables without onsets. However, as described below, it is a simplification strategy.

The early stage of onset deletion (in polysyllabic productions) is followed by a copying period, where initial onset consonants are identical to onsets of the following syllable (*mitá → titá* 'bed', *dúbi → búbi* 'teddy bear', *tarnególet → gagólet* 'hen'); this is the well know phenomenon of consonant harmony (§5.3). Finally, faithful production of initial onset consonants emerges, subject to the children's segmental development; that is *salóm* / *θalóm* for *šalóm* 'hello' is considered prosodically faithful.

(5) Stages in the acquisition of a simple onset

Onset deletion	>	***Onset copying***	>	***Target onset***	
ipúr		pipúr		sipúr	'story'
emalá		memalá		nemalá	'ant'
atína		tatína		klemantína	'tangerine'

Initial onset deletion and copying are simplification strategies in the development of the prosodic word (§2). Hebrew speaking children expand the prosodic word from right-to-left and add one syllable at a time. A new syllable is not added as a unit, but rather in stages, first the nucleus, then the onset and finally the coda (e.g. *ká ⇒ aká ⇒ maká ⇒ malká* 'queen'). In addition, each of these sub-syllabic units is not immediately filled with the target segment; first a copy of the following consonant/vowel appears, and only then the target segment.

The decrease in segmental accuracy during the expansion of the prosodic word reflects a "trade-off" effect (Bat-El 2009), whereby children simplify already acquired structures when they start producing new ones (Ferguson and Farwell 1975, Garnica and Edwards 1977, Stemberger et al. 1999). That is, the detailed path *emalá ⇒ memalá ⇒ nemalá* is not due to a late acquisition of the segment (in this case *n*), but rather to the cumulative complexity involved in adding not only a segment but also a prosodic position that hosts the segment.

4.1.2. Complex onsets: Hebrew complex onsets are composed of two consonants (three consonants appear in a few loan words) with the following combinations: obstruent–obstruent (stop–stop, stop–affricate, stop–fricative, sibilant–stop and sibilant–fricative) and obstruent-sonorant (stop–nasal/approximant, affricate–nasal/approximant, fricative–nasal/approximant, and sibilant–nasal/approximant). Hebrew-acuiring children acquire consonant clusters rather late, with 85% correct

[5] In addition, all children produce the monosyllabic consonant-free word *o* for *or* 'light' due to segmental reasons (Ben-David 2001).

productions around age 4;0 (Rosenberg 1983, Forkush 1997), or even 4;6 for clusters starting with stops (Lavie 1978).

Data from children acquiring clusters reveal several simplification strategies, classified in Ben David (2001) into five main developmental stages (see however Bloch 2011 for arguments against the stage approach):

(6) Stages in the acquisition of complex onset

	Stage	gdolá 'big fm.sg.'	tmuná 'picture'	klipá 'peel'
a.	Deletion	olá	uná	ipá
b.	Copying	lolá	nuná	pipá
c.	Reduction	dolá	muná	kipa
d.	Attempts to produce both consonants			
	i. Vowel epenthesis	gedolá		
	ii. Coalescence		puná	
	ii. Metathesis			kilpá
e.	Correct production	gdolá	tmuná	klipá

The first two stages, deletion (6) and copying (6), are not unique to the acquisition of complex onsets; they appear in the acquisition of simple onsets as well (§4.1.1). Deletion of the entire cluster (*gviná* → *iná* 'cheese') is the first stage in the development of onsets in polysyllabic productions, and onset copying (e.g. *gviná* → *niná* 'cheese') appears short time after that.

However, Karni (2012) shows that these two strategies fade quicker in target with complex onsets compared to targets with simple onsets. After a short period of deletion of both simple and complex initial onsets, children start producing a single consonant in initial complex onsets (*gviná* → *giná* 'cheese'), but continue to delete consonants in initial simple onsets (*giná* → *iná* 'garden'). This chain shift (Dinnsen and Barlow 1998, Kirchner 1996) indicates weighted faithfulness; deletion of one consonant is fine, thus allowing *gviná* → *giná* 'cheese' and *giná* → *iná* 'garden', but deletion of two consonants, as in *giná* → *iná* 'garden', is way too far from the target and thus avoided.

The third stage is cluster reduction (6), whereby only one of the target consonants in a cluster is produced. This is the most widespread simplification strategy in Hebrew (Lavie 1978, Ben-David 2001, 2006, Bloch 2011) as well as in other languages (McLeod et al. 2001, Kappa 2002, Freitas 2003, Jongstra 2003, Łukaszewicz 2007). Ben-David's (2006) cross-sectional study (40 children ages 1;10-3;0) reveals extensive C1 deletion in obstruent–obstruent clusters, where C1 is a sibilant (92%) and non-sibilant (87%). The opposite trend is found in obstruent–approximant clusters, where C1 is a sibilant (21%) and non-sibilant (12%). Obstruent–nasal clusters follow the obstruent-obstruent trend but to a lesser extent, with C1 deletion when it is a sibilant (74%) or non-sibilant (72%). This pattern continues in later ages, when cluster reduction is less common, but the contrast between the behavior of C1 and C2 is a bit softer. Lavie's (1978) cross-sectional study (200 children ages 3;0-5;0) also reveals C1 deletion in obstruent-obstruent clusters, where C1 is a sibilant (70%) and non-sibilant (76%), and the opposite trend in obstruent-approximant clusters, where C1 is a sibilant (38%) and non-sibilant (33%). In obstruent-nasal clusters, however, the trend seems to change in later ages, with a slight preference for C2 deletion (55%).

These data reveal adherence to the sonority scale (obstruents–nasals–approximents), where the closer the sonority distance between the two consonants in the cluster the higher the chance for C1 to delete. Obstruent–nasal clusters, being in the middle, between obstruent–obstruent and obstruent–approximant clusters, display midway behavior. Examples from Ben-David (2001) and Bloch (2011) are given below.

(7) Complex onset reduction

	Child	*Target*		*Child*	*Target*	
OBST-OBST	viš	kviš	'road'	tanót	ktanót	'small fm. pl.'
	voá	dvorá	'bee'	xína	txína	'tahini'
	pagéti	spagéti	'spaghetti'	sartén	psantér	'piano'
OBST-APPROX	gída	glída	'ice cream'	bodíni	blondíni	'blond'
	kavím	klavím	'dogs'	ðafrafón	šrafrafón	'stool'
	paxín	praxím	'flowers'	dakón	drakón	'dragon'
OBST-NAS	muná	tmuná	'picture'	tunót	tmunót	'pictures'
	niyót	kniyót	'shopping'	kafáim	knafáim	'wings'
	níli	tníli	'give me fm.'	ko / mo	kmo	'like'
SIBILANT-NAS	mixá	smixá	'blanket'	θaít	snaít	'squirrel fm.'
	mone	šmone	'eight'	níθel	šnicel	'schnitzel'
	náim	šnáim	'two'	se / ne	šney	'two'

Just before reaching the target complex onsets, stage (6) includes attempts to produce both consonants but not in a cluster. Three simplification strategies are employed during this stage: vowel epenthesis between the two consonants (e.g. *gviná* → *geviná* 'cheese'); coalescence, whereby features from both consonants merge into a new one (e.g. *gviná* → *biná* 'cheese'); and metathesis between C2 and the following vowel (e.g. *gviná* → *givná* 'cheese'). There are only a few examples for these strategies in Hebrew (Ben-David, 2001, 2006, Bloch 2011).

4.2. Codas: 44% of the syllables in Hebrew have a simple coda, 1% has a complex coda, and 55% are codaless. Since the absence of codas is less marked than its presence, children go through several stages until they master codas in all prosodic positions. Ben-David (2001) distinguished five such stages:

(8) Stages of coda acquisition

	Stage	bakbúk 'bottle'	píknik 'picnic'	ambátyot 'bath pl.'	agvanyót 'tomatoes'
a.	Coda deletion in all prosodic positions	babú	píni	(abá)yo	(ava)yó
b.	Faithful production of word-final and stressed codas	babúk	píni	abáyo	avayót
c.	Faithful production of all word-final codas	babúk	pínik	abáyot	avayót
d.	Faithful production of medial codas in the penultimate syllable	bakbúk	píknik	abátyot	avanyót
e.	Faithful production of all medial codas	bakbúk	píknik	ambátyot	agvanyót

During the first stage (8), codas are deleted in almost all productions, regardless of their position in the word (e.g. *kos* → *ko* 'glass', *safsál* → *sasá* 'bench'). Codas are, however, consistently preserved in onseltless monosyllabic words (e.g. *af* 'nose', *iš* 'man') in order to avoid consonant-free words (§4.1.1). Indeed, children could insert an onset, but it seems that insertion of any segment, including vowels, is rather rare during early stages of phonological development. During stage (8), codas are preserved in final stressed syllables, more so in monosyllabic productions than in polysyllabic (Kaltum-Roizman 2008), and later, during stage (8), in all final syllables regardless of stress. Preservation of medial codas appears later, during stage (8), where codas in penultimate syllables are preserved, and then during the final stage (8), where all codas are preserved.

The stages of coda development reveal that the position of the coda, i.e. whether it is in a final or medial syllable, plays a major role in the order of acquisition, with final codas appearing before medial codas. Also the prominence of the syllable hosting the coda serves as a factor, with codas appearing in stressed syllables before unstressed ones. Gishri's (2009) case study of the development of medial codas in prolonged acquisition supports the latter factor by showing that at the beginning of medial coda development there are more faithful codas in stressed syllables (47%) than in unstressed ones (24%). These percentages are not compatible with data from Hebrew CDS, where the majority of medial codas are in unstressed syllables.

In addition, Gishri (2009) found sonority effects in the acquisition of medial codas, with a clear preference (81.3%) for productions with falling sonority. Such productions respect the universal Syllable Contact Law (Vennemann 1988, Bat-El 1996), which requires a coda to be more sonorous than the following adjacent onset, and the grater the distance on the sonority scale the better; e.g. the coda-onset sequence *yc* in *beycá* 'egg' is better than the *sm* sequence in *masmér* 'nail' (see also §4.1.2 for a distance-oriented sonority effect in the acquisition of complex onsets). In the absence of liquids in his segmental inventory, the child in Gishri's study showed preference for glides and fricatives in medial codas. This complies with the order of acquisition in final codas, with fricatives and approximant (sharing the feature [+continuant]) appear before nasals, which in turn appear before stops (Ben-David 2001). However, Bat-El (2012) argues for an initial, though usually negligible stage with preference for stops in final coda position (see §5.1.1).

The acquisition of word final codas may affect the acquisition of inflectional suffixes, where the relevant distinction is the presence vs. absence of a coda in the suffix. A study of this phonology-morphology interface in two children (Bat-El 2012) reveals that one child acquired the codaless 1st person suffix *-ti* before the codaful plural suffix *-im*, while the other child displayed the reverse order of acquisition. Further examination revealed that both children started producing verb inflectional suffixes during the same developmental period, and both started producing the codaful suffix *-im* when they reached around 90% faithful final codas in all productions. The difference between the children was in the developmental period during which they reached the 90% faithful codas. The child acquiring the suffixes in the order *-im* > *-ti*, which is syntactically the expected order (Armon-Lotem 2006), reached 90% faithful final codas at the time he started producing the inflectional suffixes, and therefore could afford producing verbs like *noflím* → *falím* 'they fall' and *kofcím* → *koθím* 'they jump'. The child acquiring the suffixes in the reverse order *-ti* > *-im* started producing the inflectional suffixes before she reached the 90% faithful codas, because her coda development was slower. While waiting for the phonological stage that allows producing the codaful suffix *-im*, she started producing the codaless suffix *-ti* in words like *macáti* → *esáti* 'I found' and *siyámti* → *iyáti* 'I finished', which complied with her phonological grammar.

5. Segments

Examination of the order at which segments appear in the children's speech allows evaluating the contribution of universal principles and language-specific frequency to segmental acquisition (§5.1). When a target segment has not yet (or only recently) been acquired, it is usually substituted with another similar segment (§5.2). Harmonic substitution, however, is due to prosodic, rather than segmental development (§5.3).

5.1. Order of acquisition: We attend in this section to the acquisition of the 5 vowels in Hebrew (*i*, *u*, *e*, *o*, *a*) and 18 out of the 23 consonants (*p*, *b*, *f*, *v*, *m*, *t*, *d*, *s*, *z*, *c*, *š*, *n*, *l*, *r*, *y*, *k*, *g*, *x*).[6]

5.1.1.Consonants: A cross-sectional study of 800 children ages 2;6-6;6, divided into 8 equally distributed age groups with an age range of six months each (Ben-David 2014b) reveals the following order of acquisition.

(9) Mastering of consonants (90% accuracy)

2;6	3;0	3;6	4;0	After 6;6
m n y p b t d k g f x	l	v	r	š, s, z, c

All consonants were mastered at the same age range, both in final codas and in onsets (initial onsets in monosyllabic words and onsets of final syllables in multisyllabic words), with the exception of *g*, which was mastered a bit later in coda position (between 3;0-3;6). An accurate production of the sibilants reaches mastery level only at school age (Gabai 1986).

Observation of a single child from the onset of speech allows minute details to appear, including the distinction between word initial onsets vs. word final codas (Klein 2014). Criterion for acquisition is 50% accuracy, and the division into periods 1-23 is based on the size of the lexicon.[7]

(10) Consonant acquisition (SR 1;2-2;4)

	1	2	3	4	7	11	13	15	17	23
Initial onset:	p, b, g	t	k	d		m, x	l	r	n, v	y
Final coda:	n, x, k	t, m, f, l		d, g, r	v					y

The child acquired most of his consonants during the first four periods (150 words in the lexicon), distinguishing between onsets and codas. Stops appeared in both onset and coda position during these four periods, but sonorants (*l*, *r*, *m*, *n*) and fricatives (*x*, *f*) appeared only in codas. The first three consonants acquired in onset position were *p*, *b*, *g*, while the first three in coda position were *n*, *x*, *k*. As for individual segments, y appeared rather late in both onset and coda at the same period 23, but *n* appeared during period 1 in coda position but period 17 in onset position.

The order of acquisition and the differences between onsets and codas cannot be attributed to the distributional frequencies in the Hebrew lexicon.

(11) Frequency of Hebrew consonants

Initial onset:	m	k	t	s	p	x	š	n	b	r	g	d	c	y	l	z	f	v
	15.9	9.0	7.8	6.5	6.4	5.5	5.0	4.6	4.3	4.2	4.0	3.5	2.6	2.4	2.2	1.8	1.2	0.7

Final coda:[8]	t	n	r	m	l	x	s	k	d	v	f	š	y	g	c	z
	33.9	14.5	9.8	6.6	5.9	3.8	3.7	3.4	3.2	2.9	2.9	2.5	1.9	1.8	1.6	1.0

All Positions:	t	r	m	n	k	l	x	s	y	d	š	g	p	c	v	f	b	z
	14.6	9.7	9.1	8.8	6.8	6.6	5.4	5.1	5.0	4.2	3.9	3.6	3.1	3.1	3.0	2.8	2.6	2.3

6 We ignore *ǰ*, *č*, and *ž*, which appear in a few loan words, and the glottals *h* and *ʔ*, which rarely surface in casual speech.

7 We adopt the lexicon-based periods of development proposed in Adam and Bat-El (2008a, 2009), a methodological tool that provides a baseline for a cross-subject comparison of quantitatively-based development. The first period correlates with a lexicon of 10 words, the second with 50 words, and then each period has addition 50 words.

8 For historical reasons (post-vocalic spirantization), *p* and *b* rarely appear in coda position.

The first three consonants acquired in onset position, *p*, *b*, and *g*, are not the most frequent ones among the onsets, and the first three consonants acquired in coda position, *n*, *x*, and *k*, are not the most frequent ones among the codas in Hebrew. That is, frequency is not a major contributor to the order of consonant development.

What is, however, striking in SR's onset development (10) is that he first acquired all stops onsets, just as dictated by the universal scale of preference in onset position: stops > fricatives > nasals > approximants. However, he does not seem to comply with the scale of preference for codas (approximants > nasals > fricatives > stops) as he produces stops (*t* and *k*) very early. This, however, supports Bat-El's (2012) claim that the segments first acquired in onset position appear in coda position due to cumulative complexity, before the segments favoured in coda position start appearing.

In terms of features and contrast development (Rice and Avery 1995), SR starts in onset position with contrast in place of articulation (labial vs. coronal vs. dorsal) and voicing (voiceless vs. voiced). Only during period 11 (a lexicon of 500 words) he develops contrast in manner of articulation, stops vs. fricatives with the acquisition of *x*, and obstruents vs. sonorants with the acquisition of *m*. Also voicing seems to follow universal preferences, with appearance of voiced obsturents in onset before coda position.

5.1.2. Vowels: The acquisition of Hebrew vowels follows the scale *a* > *u*, *i* > *o*, *e* , i.e. low > high > mid vowels (Dromi et al. 1993, Ben-David 2001). This order is guided by contrast maximization (in line with the Dispersion Theory; Lindblom and Maddieson 1988, Lindblom 1986a,b, Becker-Kristal 2010), where vowels at the far corners of the vowel trapeze are produced before those close to the center. Note that this order only partially overlaps with the distributional frequency in Hebrew: *a* > *i* > *e* > *u* > *o* (based on 11,334 vowels appearing in disyllabic nouns). The low vowel *a* is indeed the most frequent vowel in Hebrew (36%) and *i* is the next in line (23%). There is, however, a mismatch with respect to *e*, which is the third in line in frequency terms (17%) but the last vowel to be acquired. This is attributed to the great degree of articulatory overlap between *e* and other vowels, which makes it less discrete and subject to variable phonetic realizations. As shown in Cohen (2014) with respect to the Hebrew rhotic, the greater the variation the later the acquisition.

Data from atypical development support the order of acquisition, with *o* and *e* being the most misarticulated vowels (Rosenberg 2003, Tubul-Lavy 2005), and *a* displaying excessive frequency (Adam and Bat-El 2008b). The child in the latter study attempted more words with *a*, and from these words he preserved the syllable with *a* regardless of its prosodic position. For example, while typically developing children produce the final and stressed syllable *mo* for *xamór* 'donkey' (§2), this child produced *xam*; similarly, *ka* instead of *pit* for *kapít* 'spoon' and *ba* instead of *buk* for *bakbúk* 'bottle'. A comparison between this child and a typically developing one during the first three stages of lexical development (100 words) reveals a quantitative gap:

(12) The percentage of *a* in two children

	Attempted targets			***Productions***		
	I	**II**	**III**	**I**	**II**	**III**
Typical:	62%	39%	38%	62%	40%	42%
Prolonged:	77%	54%	54%	88%	73%	75%

Notice that in the prolonged (thus atypical) development, there is not only higher percentage of attempted targets and productions with *a* than in the typical development, but also higher percentage of productions with *a* than attempted targets.

5.2. Substitution patterns: Before mastering a particular segment, children tend to substitute it with another one in a rather systematic manner. This is more noticeable in consonants (§5.2.1) than in vowels (§5.2.2), due to the relatively fast acquisition of the latter ones.

5.2.1. Consonants: The acquisition of consonants goes through a substitution period (Jedwab 1975, Shaked 1990, Amir 1995, Ben David 2001), where marked feature values are replaces with their unmarked counterparts.

(13) Segmental substitution

		Child	*Target*		*Child*	*Target*	
a.	Fricative → Stop:	abodá	avodá	'work'	taón	Šaón	'watch'
b.	Affricate → Fricative:	sav	cav	'turtle'	es	Ec	'tree'
c.	Lateral → Glide:	yaván	laván	'white'	kéyev	Kélev	'dog'
d.	Voiced → Voiceless:	kése	gézer	'carrot'	ot	Od	'more'
e.	Dorsal → Alveolar:	tof	kof	'monkey'	udá	Ugá	'cake'

Substitution is the strategy employed during segmental development while deletion is employed during prosodic development – the prosodic word (§2) and the syllable (§4). Substitution is systematic, where the substituting consonant is less marked than the target consonant with regard to a specific feature. Similarity with the substituted segment is maintained because substitution affects one and sometimes two feature values. For example, fricatives are replaced with stops (13) with the change in the value of the feature [continuant] from + to -, and dorsal consonants are replaced with alveolar ones (13) with the change of place of articulation. In some cases, two features are replaced within the same segment, as in *lavan* → *lapan* 'white', where in the replacement of *v* with *p* the labial place of articulation is preserve, but the value of the features [voice] and [continuant] is changed from + to -.

The Hebrew rhotic (a dorsal approximant) is acquired rather late and in a rather unique way (Ben-David 2001, Cohen 2014). First, its development involves not only substitution but also a stage of deletion (e.g. *roš* → *os* 'head', *pará* → *paá* 'cow'). Second, there is a relatively grate degree of inter-child variation with regard to the substituting consonant, which can be *y*, *x*, *l*, or even *ŋ*, where the latter is not even a phoneme in Hebrew (e.g. *pérax* → *péyax* 'flower', *or* → *ox* 'light', *kadúr* → *adúl* 'ball', *éser* → *éseŋ* 'ten').

5.2.2. Vowels: As vowels are acquired early, data on substitution is relatively rare, but the few cases we find are substitution with *a* (e.g. *lo* → *ya* 'no', *avirón* → *an* 'airplane', *et*→ *at* 'pen').

5.3. Harmony: A well-known substitution process in acquisition is harmony, which was studied mostly with regard to consonants (§5.3.1), though it appears also in vowels (§5.3.2).

5.3.1. Consonants: In the majority of cases, harmony goes regressively from onset-to-onset, where the target is the initial onset; coda-onset harmony is rare in Hebrew, and coda-coda is even less common (Ben-David 2001, 2012, Bat-El 2009, Gafni 2012a,b).

(14) Consonant harmony

	Child	*Target*		*Child*	*Target*	
ONSET-ONSET	kóko	šóko	'chocolate milk'	memalá	Nemalá	'ant'
	θiθá	kivsá	'sheep'	lalá	Simlá	'dress'
	šišáfa	d͡ʒiráfa	'giraffe'	xaxór	šaxór	'black'
CODA-CODA	súksik	čúpčik	'sharp tip'	saldál	Sandal	'sandal'
CODA-ONSET	kofáv	koxáv	'star'	kanán	Katán	'small'

In order evaluate the extent of consonant harmony it is necessary to distinguish between harmony and non-assimilatory substitution (§5.21). Gafni (2012a,b) made this distinction in a study of two typically developing children and arrived at a rather low percentage of pure consonant harmony (excluding non-assimilatory substitution), and also showed that this process ends rather early.

Although consonant harmony is classified as segmental substitution, Ben-David (2001, 2012) claims that its trigger is not segmental but rather prosodic. When children expand their prosodic words syllable by syllable, they do not add whole target syllables, but build the new syllable step-by-step (§2). Within the syllable, they start with the nucleus, then the onset and at the end the coda. For each sub-syllabic unit, as shown in (5) for the onset, they start with copying a following consonant before producing the target consonant (e.g. *íta* ⇒ *títa* ⇒ *píta* 'pitta bread', *lifők* ⇒ *likfők* ⇒ *lidfők* 'to knock'). The copying strategy is consonant harmony, which appears in the course of the development of a prosodic unit. That is, when children add a new prosodic unit, they ease on the segmental load by copying the consonant from the adjacent (usually similar) unit.

Following its role in introducing a consonant in a new prosodic position, onset-to-onset harmony in typical development is limited mostly to two consonants (Bat-El 2009); that is, *tarnególet* → *gagólet* 'hen' is common while *tarnegól* → *gagegól* 'rooster' is rare. In addition, since it disappears in a rather early age, consonant harmony is limited to maximally trisyllabic productions (Bat-El 2009); that is *kadúr* → *dadú* 'ball' is more common than *nemalá* → *memalá* 'ant', which in turn is more common than *ipopotám* → *itototám* for 'hippopotamus'. By the time the children reach quadrisyllabic productions consonant harmony has already gone.

However, data from children with atypical acquisition, in particular children with Childhood Apraxia of Speech (Tubul-Lavy 2005, Shaul-Giladi 2013) reveal consonant harmony across more than two consonants (e.g. *šókolad* → *lólola* 'chocolate', *televízya* → *dedída* 'television') and within quadrisyllabic productions (e.g. *naxliéli* → *xaxiéi* 'wagtail', *agvaniyá* → *agagiá* 'tomato'). This has been argued in Bat-El (2009) to be a case of a-synchronization between the development of the prosodic and segmental tiers in the phonological word (1).

5.3.2. Vowels: As in the case of consonant harmony, vowel harmony is attributed to prosodic development (Ben-David 2001, 2012). When a syllable is added to the prosodic word, the position of the vowel is filled with a copy of the following vowel before the target vowel surfaces (e.g. *todá* → *adá* 'thank you', *éfo* → *ófo* 'where'). Therefore, like consonant harmony, vowel harmony is predominantly regressive. Vowel harmony disappears from the children's speech even before consonant harmony, and it is also relatively rare. Cohen's (2012) longitudinal study of two children reveals that both children showed a peak in using vowel harmony (7.1%-11.9% of the disyllabic productions) at the period when they had around 150 words in their lexicon.

Longitudinal studies, as noted earlier, reveal minute details, including inter-child variation. Cohen (2012) showed segmental effects in one child, with vowel harmony from early-mastered vowels (*a*, *i*, *u*) to later acquired vowels, but prominence effects in the other child, with stressed syllables triggering vowel harmony. In general, vowel harmony starts in disyllabic words with penultimate stress, then appears in disyllabic words with final stress with a significant decline in the former words, and finally occurs in trisyllabic words while declines in disyllabic words (Ben-David 2001).

6. Concluding remarks

We have shown in this paper the paths Hebrew-acquiring children take in the course of phonological development towards the target words. We tracked stages of development with reference to each layer in hierarchical structure of the phonological word (1), as well as to the interface between layers (e.g. the development of segments with reference to their position in the syllable and/or prosodic word).

The data and generalizations provided in this paper allow considering the forces affecting phonological development in addressing the following questions:
a. Why do children produce these phonological structures and not others?
b. Why do children attempt producing these words and not others?

With regard to the first question, there are two opposing, though partially overlapping approaches – the usage-based approach (Tomasello 2003 among others) and the generative approach. Both approaches grant children with innate tools essential for the acquisition of their first language, but they differ with respect to the nature of the toolbox from which these tools are drawn. For the usage-based approach, these tools are drawn from a general cognitive toolbox and are not specific to language. For the generative approach, there is a toolbox specific to linguistic knowledge within the general cognitive toolbox.

When it comes to the acquisition of phonology, the two approaches often converge. Universal phonological constraints and markedness are in most cases phonetically grounded (articulation and/or perception) and typologically supported by inter- and intra-language distributional frequencies. For example, the fact that *t* is acquired early can be due ease of articulation and distributional frequency.

However, languages are not always user-friendly, and for various (often historical) reasons, a phenomenon in a language may develop to be inconsistent, unnatural (Anderson 1981), and anti-universal. In such cases, as argued in Adam and Bat-El (2009), when children cannot draw generalizations from the input data, they use their innate universal constraints. The acquisition of Hebrew stress (§3) is such a case, where the children's clear preference for the trochaic foot (penultimate stress) is not supported by frequency, perception or articulation. In the acquisition of segments (§4), however, we see joint forces of perception, ease of articulation, variation, frequency and universal markedness. Linguists that grant children with powerful statistical capacity cannot deny them from the inherent propensity to use all sources.

Moreover, children are selective learners, as their development shows avoidance of structures that do not comply with their grammar during a given stage (Ferguson and Farwell 1975, Waterson 1978, Schwartz 1988, Becker 2012, Bat-El 2012). This answers our second question – why do children chose one target and not another. For example, children refrain from producing a certain suffix because its structure does not comply with their phonological grammar (§4.2), and children attempt trochaic words during the pre-MW stage (§3).

Space limits allowed only short answers to these important questions, but we hope these answers will encourage future research attending to the combined forces at the children's disposal in the course of language acquisition.

REFERENCES

Adam, Galit. 2002. *From Variable to Optimal Grammar: Evidence from Language Acquisition and Language Change*. Ph.D. dissertation, Tel-Aviv University.

Adam, Galit and Outi Bat-El. 2008a. The trochaic bias is universal: Evidence from Hebrew. In A. Gavarró and M.J. Freitas (eds), *Language Acquisition and Development: Proceedings of GALA 2007*, 12-24. Newscastle: Cambridge Scholars Publishing.

Adam, Galit and Outi Bat-El. 2008b. Segmental effects on syllable selection: Evidence from Hebrew. In A. Gavarró and M.J. Freitas (eds), *Language Acquisition and Development: Proceedings of GALA 2007*, 1-11. Newscastle: Cambridge Scholars Publishing.

Adam, Galit and Outi Bat-El. 2009. When do universal preferences emerge in language development? The acquisition of Hebrew stress. *Brill's Annual of Afroasiatic Languages and Linguistics* 1:1-28.

Adi-Bensaid, Limor. 2006. *The Prosodic Development of Hebrew-Speaking Hearing Impaired Children*. Ph.D. dissertation, Tel-Aviv University.

Adi-Bensaid, Limor and Outi Bat-El. 2004. The development of the prosodic word in the speech of a hearing impaired child with a cochlear implant device. *Journal of Multilingual Communication Disorders* 2:187-206.

Adi-Bensaid, Limor and Gila Tubul-Lavy. 2009. Consonant-free words: Evidence from Hebrew speaking children with cochlear implants. *Clinical Linguistics and Phonetics* 23:122-132.

Amir, Sharon. 1995. First language acquisition. *Journal of the Israeli Speech, Language and Hearing Association* 18:37-50. [in Hebrew]

Allen, George D. and Sarah Hawkins. 1978. The development of phonological rhythm. In A. Bell and J.B. Hooper (eds), *Syllables and Segments*, 173-185. Amsterdam: North-Holland Publishing Company.

Anderson, Stephen R. 1981. Why phonology isn't 'Natural'. *Linguistic Inquiry* 12:493-539.

Armon-Lotem, Sharon. 2006. Subject use and the acquisition of verbal agreement in Hebrew. In N. Gagarina and I. Guelzow (eds), *Acquisition of Verb Grammar and Verb Arguments*, 269-291. Dordrecht: Kluwer Academic Publishers.

Bat-El, Outi. 1996. Selecting the best of the worst: The grammar of Hebrew blends. *Phonology* 13:283-328.

Bat-El, Outi. 2009. Harmonic domains and synchronization in typically and atypically developing Hebrew-speaking children. *Language Sciences* 31:117-135.

Bat-El, Outi. 2005. The emergence of the trochaic foot in Hebrew hypocoristics. *Phonology* 22:1-29.

Bat-El, Outi. 2011. Semitic templates. M. van Oostendrop, C. Ewen, E. Hume, and K. Rice (eds), *Blackwell Companion to Phonology*, 2586-2608. Malden, MA: Wiley-Blackwell.

Bat-El, Outi. 2012. The Sonority Dispersion Principle in the acquisition of Hebrew word final codas. In S. Parker (ed.), *The Sonority Controversy*, 319-344. Berlin: Mouton de Gruyter.

Bat-El, Outi. to appear. Staying away from the weak left edge: A strengthening strategy. In S. Bendjaballah, N. Faust, M Lahrouchi and N. Lampitelli (eds), *The form of Structure, the Structure of Forms*. Amsterdam: John Benjamins.

Battistella, Edwin L. 1996. *The Logic of Markedness*. New York: Oxford University Press.

Becker, Michael. 2002. *Hebrew Stress: Can You Hear Those Trochees?* M.A. thesis, Tel-Aviv University.

Becker, Michael. 2012. Target selection in Error Selective Learning. *Brill's Annual of Afroasiatic Languages and Linguistics* 4:120-139.

Becker-Kristal, Roy. 2010. *Acoustic Typology of Vowel Inventories and Dispersion Theory: Insights from a Large Cross-Linguistic Corpus*. Ph.D. dissertation, UCLA.

Ben-David, Avivit. 2001. *Language Acquisition and Phonological Theory: Universal and Variable Processes Across Children and Across Languages*. Ph.D. dissertation, Tel-Aviv University. [in Hebrew]

Ben-David, Avivit. 2006. On the acquisition of Hebrew #sC onsets. *Journal of Multilingual Communication Disorders* 4:205-217.

Ben-David, Avivit. 2010. Initial consonant deletion: An atypical or a typical process? A paper presented at the *13th International Phonetics and Linguistics Conference*, Oslo, Norway.

Ben-David, Avivit. 2012. The development of prosodic structure: Evidence from typical longitudinal data. *Brill's Annual of Afroasiatic Languages and Linguistics* 4:55-79.

Ben-David, Avivit. 2014a. Stress or position: Deciding between prominence and position in prosodic development. A paper presented at the *15th International Clinical Linguistics and Phonetic conference*, Stockholm, Sweden.

Ben-David, Avivit. 2014b. Norms in Hebrew phonological acquisition. A paper presented at the *50 Annual Meeting of the Israeli Association for Speech, Hearing, and Language* (ISHLA), Tel-Aviv, Israel.

Ben-David, Avivit and Outi Bat-El. 2015. Strong vs strong, but which is stronger? Stressed and final syllables in language acquisition. A paper presented at the *Annual Meeting of Deutsche Gesellschaft für Sprachwissenschaft*. Leipzig, Germany.

Bloch, Tamar. 2011. *Simplification Patterns in the Acquisition of Word Initial Consonant Clusters in Hebrew*. M.A. thesis, Tel-Aviv University.

Bolozky, Shmuel and Michael Becker. 2010. *Living Lexicon of Hebrew Nouns*. Ms., University of Massachusetts Amherst. http://www.phonologist.org/LLHN.

Cohen, Evan-Gary. 2012. Vowel harmony and universality in Hebrew acquisition. *Brill's Annual of Afroasiatic Languages and Linguistics* 4:7-29.

Cohen, Evan-Gary. 2014. Phonetically-based biases in the acquisition of Hebrew Rhotics. A paper presented at the *LAGB Annual Meeting*, Oxford, UK.

Cohen-Gross, Dalia. 1997. *The Morphological-Syllabic Structure of Modern Hebrew*. Ph.D. Dissertation, Bar-Ilan University. [in Hebrew]

Clements, Nick G. 1990. The role of the sonority cycle in core syllabification. In J. Kingston and M. Beckman (eds), *Papers in Laboratory Phonology I: Between the Grammar and Physics of Speech*, 283-333. Cambridge: Cambridge University press.

Clements, Nick G. 1985. The geometry of phonological features. *Phonology Yearbook* 2:225-252.

Clements, Nick G. and Elizabeth Hume. 1995. The internal organization of speech sounds. In J. Goldsmith (ed.), *Handbook of Phonology*, 245-306. Blackwell.

Dinnsen, Daniel A. and Jessica Barlow. 1998. On the characterization of a chain shift in normal and delayed phonological acquisition. *Journal of Child Language* 25:61-94.

Dromi, Esther, Tova Most and Naama Yehuda. 1993. The case of homonymy in early lexical development: Interactional and acoustical analyses. Paper presented at the *6th International Congress for the Study of Child Language*, Trieste, Italy.

Duanmu, San. 2007. *The Phonology of Standard Chinese*. Oxford: Oxford University Press.

Echols, Catharine H. and Elissa L. Newport. 1992. The role of stress and position in determining first words. *Language Acquisition* 2:189-220.

Ferguson, Charles A. and Carol B. Farwell. 1975. Words and sounds in early language acquisition. *Language* 51:419-430.

Forkush, Erika. 1997. *The Effect of Word-Stress on the Acquisition of Initial Consonant Clusters in Hebrew*. Ms., Tel Aviv University. [in Hebrew]

Freitas, Maria João. 2003. The acquisition of onset clusters in European Portuguese. *Probus* 15: 27-46.

Gafni, Chen. 2012a. *Consonant Harmony in the Scope of Language Development*. M.A. thesis, Tel-Aviv University.

Gafni, Chen. 2012b. Child consonant harmony: Identification and properties. *Brill's Annual of Afroasiatic Languages and Linguistics* 4:30-54.

Gafni, Chen. 2014. *Child Phonology Analyzer* [computer program]. Version 4.7.1, retrieved 17 September 2014 from: http://chengafni.wordpress.com/cpa.

Gishri, Michal. 2009. *The Role of Prominence in the Acquisition of Medial Codas in Hebrew: Evidence from a Slow Developer*. M.A. thesis, Tel-Aviv University.

Garnica, Olga K. and Mary Louise Edwards. 1977. Phonological variation in children's speech: The trade-off phenomenon. *Working Papers in Linguistics, Ohio State University* 22: 81-87.

Graf, Dafna and Adam Ussishkin. 2003. Emergent iambs: Stress in Modern Hebrew. *Lingua* 113: 239-270.

Guillaume, Antoine. 2008. *A Grammar of Caviñea*. Berlin: Mouton de Gruyter.

Jedwab, Dana. 1975. *An Articulation Test as a Prognostic Tool for Functional Articulation Disorders in Children Ages 6-8*. M.A. thesis, Tel-Aviv University.

Jongstra, Wenckje. 2003. *Variation in Reduction Strategies of Dutch Word-initial Consonant Clusters*. Ph.D. dissertation, University of Toronto, Canada.

Kaltum-Royzman, Keren. 2008. *The Effect of Position, Word Length and Manner of Articulation on Coda Productions in Hebrew-speaking Children*. M.A. thesis, Tel-Aviv University. [in Hebrew]

Kappa, Ionna. 2002. On the acquisition of syllabic structure in Greek. *Journal of Greek Linguistics* 3:1-52.

Karni, Noa. 2011. *Chain Shift and Local Constraint Conjunction in the Acquisition of Hebrew Onsets*. M.A. thesis, Tel-Aviv University.

Karni, Noa. 2012. Minimizing Faithfulness Violation in the Acquisition of Hebrew Onset. *Brill's Annual of Afoasiatic Languages and Linguistics* 4:80-103

Kirchner, Robert. 1996. Synchronic chain shifts in Optimality Theory. *Linguistic Inquiry* 27:341-350.

Klein, Stav, 2014. *Nature or Nurture? The acquisition of consonants in Modern Hebrew*. Ms., Tel-Aviv University.

de Lacy, Paul. 2006. *Markedness: Reduction and Preservation in Phonology*. Cambridge: Cambridge University Press.

Lavie, Shulamith. 1978. *Norms of Acquiring the Consonants in Hebrew in Children Aged 3 to 5 Years*. M.A. thesis, Tel-Aviv University. [in Hebrew]

Lindblom Björn. 1986a. Phonetic universals in vowel systems. In J.J. Ohala and J.J. Jaeger (eds), *Experimental Phonology*, 13-44. New York: Academic Press.

Lindblom, Björn. 1986b. On the origin and purpose of discreteness and invariance in sound patterns. In J. Perkell and D. Klatt (eds), *Variance and Variability of Speech Processes*, 493-510. New Jersey: Lawrence Erlbaum.

Lindblom, Björn and Ian Maddieson. 1988. Phonetic universals in consonant systems. In L.M. Hyman and C.N. Li (eds), *Language, Speech and Mind*, 62-78. London: Routlege.

Łukaszewicz, Beata. 2007. Reduction in syllable onsets in the acquisition of Polish: Deletion, coalescence, metathesis and gemination. *Journal of Child Language* 34:53-82.

McCarthy, John J. and Alan Prince. 1986. *Prosodic Morphology*. Rutgers Technical Report TR-32. New Brunswick, Rutgers University Center for Cognitive Science.

McLeod, Sharynne, Jan van Doorn, and Vicki A. Reed. 2000. Normal acquisition of consonant clusters. *American Journal of Speech and Language Pathology* 10:99-110.

Nespor, Marina and Irene Vogel. 1986. *Prosodic phonology*. Dordrecht: Foris.

Prince, Alan. 1980. A metrical theory for Estonian quantity. *Linguistic Inquiry* 11: 511-562.

Rice, Keren. 2007. Markedness in phonology. In P. de Lacy (ed.), *The Cambridge Handbook of Phonology*, 79-97. Cambridge: Cambridge University Press.

Rice, Keren and Peter Avery.1995. Variability in a deterministic model of language acquisition: A Theory of segmental elaboration. In J. Archibald (ed.), *Phonological Acquisition and Phonological Theory*, 23-42. Hillsdale, N.J.: Erlbaum.

Rosenberg, Adi. 2003. *Phonological Acquisition Patterns of an SLI Child: Constraint Ranking in the Impaired Phonological System*. M.A. thesis, Tel Aviv University. [in Hebrew]

Rosenberg, Liliana. 1983. *Developmental stages in acquisition of initial consonant clusters by Hebrew-speaking children*. Ms., Tel Aviv University. [in Hebrew]

Schwartz, Richard. 1988. Phonological factors in early lexical acquisition. In M. Smith and J. Locke (eds), *The Emergent Lexicon: The Child's Development of a Linguistic Vocabulary*, 185-222. San Diego: Academic Press.

Segal, Osnat, Bracha Nir-Sagiv, Liat Kishon-Rabin and Dorit Ravid. 2008. Prosodic patterns in Hebrew child-directed speech. *Journal of Child Language* 29:239-49.

Selkirk, Elisabeth O. 1982. *The Syntax of Words*. Cambridge, MA: MIT Press.

Shaked, Galia. 1990. *Early Phonological Acquisition: Phonological Processes between Ages 1;7–2;7*. M.A. thesis, Tel Aviv University. [in Hebrew]

Shaul-Giladi, Shani. 2013. *Atypical Phonological Phenomenon in Hebrew-speaking Children with Phonological Disorders*. M.A. thesis, Tel Aviv University. [in Hebrew]

Stemberger, Joseph P., Barbara H. Bernhardt and Carolyn E. Johnson. 1999. "Regressions" ("u"-shaped learning) in the acquisition of prosodic structure. Poster presented at the *6th International Child Language Congress* (ROA-471).

Stern-Sabach, Ifat. 2013. Motivations for vowel epenthesis in early language acquisition. Ms., Tel-Aviv University.

Tomasello, Michael. 2003. Constructing a Language: *A Usage-Based Theory of Language Acquisition*. Cambridge, MA: Harvard University Press.

Tubul-Lavy, Gila. 2005. *The Phonology of Hebrew Speaking Dyspraxic Children*. Ph.D. dissertation, Tel-Aviv University. [in Hebrew]

Vennemann, Theo. 1988. *Preference Laws for Syllable Structure*. Berlin: Mouton de Gruyter.

Waterson, Natalie. 1978. Growth of complexity in phonological development. In N. Waterson and C. Snow (eds), *The Development of Communication*, 415-442. Chichester: Wiley.