To appear in: Bendjaballah and Reintges (eds) *The Oxford Guide to the Afroasiatic Languages*
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PROSODIC DEVELOPMENT IN ARABIC AND HEBREW: UNIVERSAL AND LANGUAGE-SPECIFIC EFFECTS

OUTI BAT-EL and AVIVIT BEN-DAVID
Tel-Aviv University and *Hadassah Academic College*

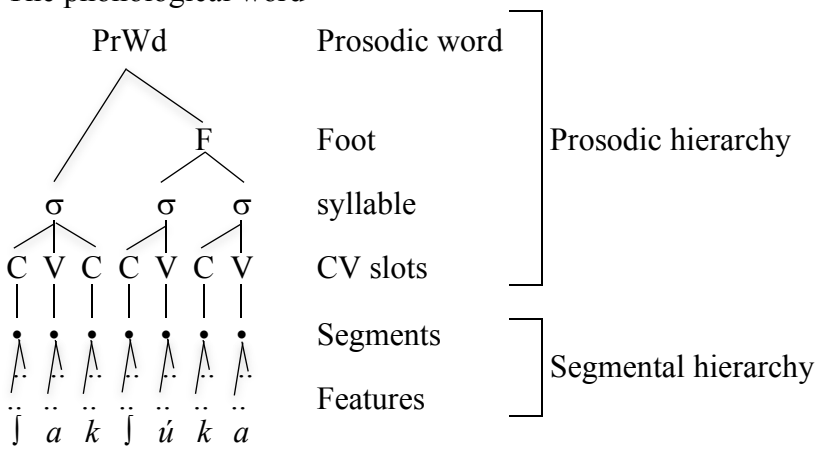
Abstract: Research on the acquisition of Semitic phonology is mostly limited to Hebrew and Arabic, and so is the present paper, which is based on data from early speech. We approach the data from two angles: (i) the children's productions and the principles active in their phonological system; and (ii) the correspondences between productions (children) and targets (adults), which reveal the strategies children employ to satisfy the phonological principles in their system. We limit the discussion to the prosodic structure of the word, and in light of the differences between Arabic and Hebrew phonology, we also attend to the interaction between language-specific and universal principles,

Key words: Arabic, Hebrew, language acquisition, phonology, prosodic word, syllable, onset, coda, clusters, geminates, stress, trochaic bias, universal principles, statistical learning.

1. Introduction

Children's phonological development, and language development in general, tends to follow typical paths; for example, CV syllables are produced before CVC syllables, and /t/ is produced before /t͡ʃ/. In this paper, we follow these paths with reference to the phonological word in (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). Due to space limitation, we do not discuss here segmental development, though segments are addressed when relevant.

(1) The phonological word



Our data are obtained from the early speech of monolingual children, whose target language is either Arabic or Hebrew; unfortunately, qualitative data on the acquisition

of other Semitic languages are rare.[1] Although genetically related, Arabic and Hebrew are phonologically dissimilar, thus allowing us to tease apart universal from language specific effects on phonological development, where language specific effects are mostly distributional frequency. This is a challenging task because frequency and universal principles often converge in their predictions, as marked structures are less frequent than unmarked ones, not only cross-linguistically but also within a language. We use the term *markedness* (Jakobson 1962, 1968, Battistella 1996, de Lacy 2006, Rice 2007) with reference to universal typological preferences and refer to *frequency* when seeking for language-specific effects.

We approach the data from two angles: (i) the principles active in the children's phonological system, i.e. their grammar; and (ii) the correspondences between the children's productions and the adults' targets, which allow detecting the variety of strategies children employ in accommodating the target words to their phonological system.

We proceed with the acquisition top-down on the phonological word (1), starting with the acquisition of the prosodic word (§2). We then attend to the foot (§3) in our discussion on the acquisition of stress system. The discussion on the syllable (§4) concentrates on the stages of the acquisition of (simple and complex) onsets and codas, with emphasis on simplification strategies. We conclude with a brief discussion on the forces playing a role in phonological development (§5).

2. Prosodic Word

Hebrew- and Arabic-acquiring children are exposed to words consisting of 1-4 syllables. The distribution of word-size in Child Directed Speech (CDS), provided below for Palestinian Arabic (Jaber et al. 2019) and Hebrew (Segal et al. 2008), reveals the dominance of disyllabic words.

[1] Arabic is not a single language, and we thus distinguish among the various studies on the acquisition of Arabic, in particular Abdoh (2010) on Hijazi Arabic (HA), Ayyad (2011) and Alqattan (2015) on Kuwaiti Arabic (KA), and Saleh et al. (2007) Egyptian Arabic (EA). The data from Palestinian Arabic (PA) and Hebrew (HEB) are drawn mostly from the authors' corpora. When relevant, we distinguish between Palestinian Arabic – North (PA-N) and Palestinian Arabic – Center (PA-C) with reference to the dialects spoken in the north and center parts of Israel, respectively.

(2) Word size in Child Directed Speech (tokens)

	1σ	**2σs**	3σs	4σs
PA	22.8%	**51.3%**	22.2%	3.7%
HEB	11%	**58%**	28%	5%

This distribution accords with the Semitic-type morphology of Arabic and Hebrew, where the size of major lexical items is confined to prosodic templates, which, in turn, hold to the MINIMAL WORD constraint (McCarthy 1981, 1993, McCarthy and Prince 1986, 1990a, Ussishkin 2000; see a review in Bat-El 2011). This universal constraint is derived from the prosodic hierarchy in (1), where the prosodic word dominates a foot, and the foot, in turn, obeys FOOT BINARITY (Prince 1980). The MINIMAL WORD constraint thus limits the minimal and/or maximal size of the word to two prosodic units, either two moras or two syllables.

The mora plays a major role in Arabic, where the distinction between light syllables (CV – 1 mora), heavy syllables (CVV, CVC – 2 moras), and super-heavy syllables (CVVC, CVCC – 3 moras) is relevant to various phonological phenomena (e.g. stress, syncope). The minimal word in Arabic is bimoraic and the maximal word is disyllabic (McCarthy 1993, Watson 2002), but the latter restriction is not rigid. While there are no major lexical items below the bimoraic minimum, there are plenty of words exceeding the disyllabic maximum, such as loanwords and affixed words (e.g. PA-N: *talfizjó:n* 'television', *ʃukalá:ta* 'chocolate', *múħtaref* 'courtesy', *tabaʕíjje* 'dependence').

Unlike Arabic, Hebrew does not distinguish between light and heavy syllables (Bat-El 2018, Bat-El et al. 2019), and word-size is thus defined in terms of syllables alone. Monosyllabic words (e.g. *pe* 'mouth', *jad* 'hand', *ʃaʁ* 'to sing') constitute a small percentage of the vocabulary (around 5%), and words exceeding the disyllabic maximum are, as in Arabic, mostly loanwords or with an affix (e.g. *televízja* 'television', *ʃókolad* 'chocolate', *mamterá* 'sprinkler', *jaldutijút* 'childishness').

The MINIMAL WORD constraint plays a major role during early stages of acquisition (Demuth and Fee 1995, Demuth 1996), regardless of the target language, be it Dutch (Fikkert 1994), Greek (Kappa 2002), or Japanese (Ota 2003). Consequently, the dominance of this constraint in the early speech of Arabic and Hebrew, as described below, cannot tease apart universal and language-specific effects on language acquisition; as it is often the case, the predictions of universal constraints and language-specific distribution converge.

2.1. The minimal word stage

There is a rather dominant period in the course of acquisition, called the minimal word stage (hereafter MW), where the maximal word size of children's productions is limited by the MINIMAL WORD constraint. Consequently, target words longer than two syllables are truncated.

(3) MW stage: Disyllabic productions (Sanalla-Shehadeh 2016, Ben-David 2001)

	Child	*Target*		*Child*	*Target*	
PA-N	tá:bi	tˤá:bi	'ball'	sobá:k	ʃobá:k	'window'
	lá:si	fará:ʃi	'butterfly'	taló:n	bantˤaló:n	'trousers'
	láta	ʃokolá:ta	'chocolate'	tabá:t	mokaʕabá:t	'building blocks'
HEB	fáfa	d͡ʒiʁáfa	'giraffe'	apít	kapít	'tea spoon'
	kófe	kóʁenfleks	'cornflakes'	taté	matáté	'broom'
	kádo	avokádo	'avocado'	fefón	melafefón	'cucumber'

Recall, however, that Arabic is a moraic language and thus monosyllabic bimoraic productions also obey the MINIMAL WORD. Therefore, in addition to disyllabic productions, there are also monosyllabic bimoraic productions during the MW stage, which correspond to target words with a final super-heavy CVVC syllable (super-heavy CVCC syllables are not produced at this early stage due to the prohibition on complex codas; see §4.3)

(4) MW stage: Bimoraic monosyllabic productions in Hijazi Arabic (Abdoh 2010)

Child	*Target*		*Child*	*Target*	
di:d	lazí:z	'delicious'	fo:n	tilifó:n	'phone'
mú:n	laimú:n	'lemon'	ka:n	burtugá:n	'orange'
to:k	baskó:t	'biscuit'	ki:m	ʔiskirí:m	'ice cream'

2.2. Other developmental stages

There are two rather short periods prior to the MW stage: the sub-MW and the pre-MW (Ben-David 2001, Adam 2002). During the ***sub-MW stage***, children produce monomoraic and thus monosyllabic words, violating the MINIMAL WORD constraint.

(5) Sub-MW stage: CV words

	Child	*Target*		*Child*	*Target*	
HA	pa	tuffá:ħa	'apple'	ba	dabbá:b	'bike'
	sa	ʃáʕar	'hair'	mə	mo:z	'banana'
	ka	sámaka	'fish'	be	be:t	'house'
HEB	ba	báit	'house'	ba	balón	'balloon'
	pa	taχpóset	'costume'	ta	taʁnegól	'rooster'
	bu	ótobus	'bus'	ni	duvdevaním	'cherries'

The distribution of CV words in the children's productions is rather low. Only 10% of the productions of the youngest group (12-15 months) in Abdoh (2010) produced CV words. Similarly, the first ten words produced by Hebrew-acquiring children already include disyllabic words (Ben David 2001). Such low distribution may suggest that there is no sub-MW stage, in particular given that during this period, the MINIMAL WORD constraint is violated.

Note, however, that CV is the unmarked syllable (see §4), and it is thus possible that during this stage children have access only to the syllable layer in (1), thus ignoring the prosodic words (Fee 1992). An alternative explanation may rely on the role of input frequency in language acquisition (Saffran et al. 1996, Pierrehumber 2003), attributing the scarcity of submininal CV words to their distribution in the target language. That is, the sub-MW stage is a developmental stage, but it is hardly visible when the frequency of sub-minimal words in the target language is low. While this explanation warrants quantitative cross-linguistic study, frequency-independent evidence for the sub-MW stage can be drawn from atypically slow development, where a child acquiring Hebrew had a majority of monosyllabic productions during the entire first year of speech (Adam and Bat-El 2008a). Although only 11% of the word tokens in CDS are monosyllabic (see (2)), 82% of the child's productions (tokens) were monosyllabic during the first 11 month of speech (1;3-2;01). This in compression with a typically developing child, who reached 28% of monosyllabic productions (tokens) by the age of 1;5. We thus maintain the view that there is a sub-MW stage in the phonological development of Hebrew and Arabic, but it is very short, unless the development is atypically slow, where each developmental stage may stretch for longer time.

The second stage prior to the MW stage is the ***pre-MW stage***, during which target words with final stress are still monosyllabic while those with nonfinal stress are already disyllabic. In Arabic, the final stressed syllable is super-heavy, and therefore the MINIMAL WORD constraint is respected during this stage. In Hebrew, however, the

production of words corresponding to target words with final stress is still sub-minimal during this period.

(6) Pre-MW stage

	Non-Final stress			*Final stress*		
	Child	*Target*		*Child*	*Target*	
HA	kóka	ʃó:ka	'fork'	fo:n	tilifó:n	'phone'
	já:la	sajjá:ra	'car'	to:k	baskó:t	'biscuit'
	nó:na	balló:na	'balloon'	ta:n	fustá:n	'dress'
HEB	téfon	télefon	'telephone'	ba	bubá	'doll'
	téti	spagéti	'spaghetti'	ka	neʃiká	'kiss'
	tína	klemantína	'tangerine'	tam	ipopotám	'hippopotamus'

The stress-related contrast is attributed to the perceptual prominence of the final and the stressed syllables, which favors penultimate stress (see §3). This perceptual prominence is further supported by the post-MW sub-stages displayed in (7) below, which, again, show that words with non-final stress "grow faster" than words with final stress. As words consisting of more than two syllables are not common in both languages (see (2)), we found data for each sub-stage for one language or the other. However, we assume that these sub-stages are relevant for both languages, and await further study for verification.

(7) Post-MW sub-stages

a. 3 syllables with non-final stress vs. 2 syllable with final stress (Hijazi Arabic)

Non-Final stress			*Final stress*		
Child	*Target*		*Child*	*Target*	
ʔanó:na	balló:na	'balloon'	ʔaló:n	bantˁaló:n	'trousers'
tawwárti	ʔatʕawwárti	'got hurt'	buká:n	burtugá:n	'orange'
ʒaʔá:na	wad͡ʒaʕá:na	'sick'	ʔisjó:n	tilifizjó:n	'television'

b. 3 syllables maximum in both final and non-final stress (Hebrew)

Non-Final stress			*Final stress*		
Child	*Target*		*Child*	*Target*	
gagólet	taʁnególet	'hen'	ulasím	meʃulaʃím	'triangles'
ikóteʁ	elikópteʁ	'helicopter'	akijá	χanukijá	'Menorah'
azíza	televízja	'television'	adión	akoʁdión	'accordion'

c. 4 syllables with non-final stress vs. 3 syllable with final stress (Hebrew)

Non-Final stress			*Final stress*		
Child	*Target*		*Child*	*Target*	
televíza	televízja	'television'	mafefón	melafefón	'cucumber'
mipaáim	mispaʁáim	'scissors'	popotám	ipopotám	'hippopotamus'
piʁamída	piʁamída	'pyramid'	kikijót	naknikijót	'sausages'

The stages in the development of the prosodic word are summarized below:

(8) The prosodic word – stages of development

				Non-final stress	*Final stress*
a.	Sub-MW	(ARB & HEB)		1μ	
b.	Pre-MW	(HEB)		2σ	1σ
c.	MW	(ARB & HEB)		2σ	$2\sigma/1\sigma_{\mu\mu}$
d.	Post-MW	(ARB)	i.	3σ	2σ
		(HEB)	ii.	3σ	3σ
		(HEB)	iii.	4σ	3σ

The prosodic word usually develops ahead of other levels in the phonological representation of the word, and therefore during the final stage, as shown in (9) below, segments and syllables are not entirely faithful to their targets.

(9) Productions during the final stage of the prosodic development

	Child	*Target*		*Child*	*Target*	
HA	battaló:n	bantˁaló:n	'trousers'	sukəlá:ta	ʃukəlá:ta	'chocolate'
	ʔámaka	sámaka	'fish'	ʔaffú:l	ʔasˁfú:r	'bird'
	tamá:tin	tˁamá:tˁim	'tomato'	bakkú:t	baskó:t	'biscuit'
HEB	adedá	nadnedá	'swing'	nakikijót	naknikijót	'sausages'
	ábuge	ámbuʁgeʁ	'hamburger'	mejapepó	melafefón	'cucumber'
	diáfa	d͡ʒiʁáfa	'giraffe'	kematína	klemantína	'tangerine'

3. Stress

Arabic and Hebrew differ in the distribution of the stress patterns, with Arabic being predominantly penultimate while Hebrew predominantly final (Jaber et al. 2019, Alqattan 2015, Segal et al. 2008).

(10) Distribution of stress patterns in CDS (tokens)

	Final	*Penult.*	*Antepenult.*	*Total*
PA-C	19% (464)	**77%** (1,898)	4% (96)	2,458
KA	29% (4420)	**71%** (10665)	0% (27)	15,112
HEB	**69% (1553)**	31% (701)		2,255

Arabic and Hebrew also differ with respect to the stress system, with Arabic being systematic and Hebrew being lexicalized in the nominal paradigm.

In many Arabic dialects, stress resides within the trisyllabic window, depending on syllable weight (Broselow 1976, McCarthy 1979, Hayes 1995, Watson 2002, 2011). Here we take San'ani Arabic (Watson 2002) as a representative example: stress is on the final super-heavy syllable, i.e. CVVC or CVCC (e.g. *maktú:b* 'letter', *darást* 'learnt 1/2MS.SG'); in the absence of a final super-heavy syllable, stress is on the penultimate heavy syllable, i.e. CVV or CVC (e.g. *maká:tib* 'offices', *migámbar* 'sitting'); otherwise, stress is on the antepenultimate syllables (e.g. *maktábati:* 'my library').

Also in Hebrew stress falls within the trisyllabic window (with a handful of exceptions subject to variation), but here the structure of the syllable is not relevant (Bat-El 1993, 2005, 2018, Graff 1999, Becker 2002, Graf and Ussishkin 2003, Bat-El et al. 2019); a CV syllable can be stressed anywhere in the word (*mataná* 'gift', *banána* 'banana', *télefon* 'phone'), and stress can be penultimate or final regardless of the structure of the syllable (e.g. *séla* 'rock', *sélek* 'beetroot', *mapá* 'map', *mapál* 'water fall'). Consequently, stress is lexical, i.e. marked (at least partially) in the lexicon, with minimal pairs within a lexical category (e.g. *bókeʁ* 'morning' – *bokéʁ* 'cowboy') and across lexical categories (e.g. *dáχaf* 'urge' – *daχáf* 'to push'). The stress system in verbs is relatively regular compared to nouns (Graf and Ussishkin 2003, Bat-El et al. 2019), but since nouns are acquired and produced before verbs and more than verbs, in Hebrew (Berman 1999) as in most languages (Waxman et al. 1995), we can safely say that children acquiring Hebrew are challenged by conflicting evidence with regard to the stress pattern.

Despite the differences between the target languages in both the stress systems and the distribution of the stress patterns, children acquiring Arabic and Hebrew show similar tendencies. There is a preference for penultimate stress, not only in Arabic where penultimate stress is statistically dominant (Abdo 1969, Abdoh 2010, Alqattan 2015), but also in Hebrew where stress is predominantly final (Ben-David 2001, Adam and Bat-El 2008b, 2009, Ben-David and Bat-El 2016). Words with penultimate stress grow faster than words with final stress in terms of number of syllables (see §2), and children adjust target words with final stress more than with penultimate

stress. As shown in (11) below, adjustment is done either via epenthesis at the end of the word or stress shift.

(11) Strategies employed to avoid final stress in polysyllabic productions

	Vowel epenthesis			*Stress shift*		
	Child	*Target*		*Child*	*Target*	
HA	líbbu	ħalí:b	'milk'			
	kó:ta	baskó:t	'biscuit'			
	tá:ta	gitˁá:r	'train'			
HEB	náva	aʁnáv	'rabbit'	jíson	liʃón	'to sleep'
	ogáwa	ogéʁ	'hamster'	avúna	afuná	'pees'
	sagóla	sagól	'purple'	búʒit	χipuʃít	'beetle'

Note that while epenthesis is found in both Arabic and Hebrew, stress shift is found only in Hebrew. This distinction is attributed to the difference in the stress systems – regular in Arabic vs. lexical in Hebrew. Regular systems are acquired earlier (other things being equal), and therefore, children probably acquire the Arabic stress system before the onset of speech; consequently, productions are error-free with respect to stress. Irregular systems, such as the one in Hebrew, take longer to acquire and errors during early speech are thus common; given the variety of contrastive stress patterns in Hebrew, stress shift results in a licit stress pattern.

A controversial claim, known as the "trochaic bias" (Allen and Hawkins 1978), credits children with a natural, thus universal preference for the trochaic foot (we analyze final stress as iambic and non-final as trochaic). The acquisition of Arabic stress, like that of English and Dutch, does not support or refute the trochaic bias as a universal tendency, since its stress system is trochaic, either on the moraic level (e.g. PA-N *bantˁa[ló:n]*$_F$ 'trousers') or the syllabic level (e.g. PA-N *ta[lá:tɪ]*$_F$ 'three'). The acquisition of Hebrew stress, however, provides positive support to the trochaic bias as a universal preference. Although Hebrew stress is predominantly final (~70%), children prefer non-final stress in their early productions as well as in the target words they select (Adam and Bat-El 2008b, 2009). Thus, during the stage where target words with final stress are reduced to monosyllabics (e.g. *mataná* → *ná* 'gift') or undergo stress shift (e.g. *mataná* → *tána* 'gift'), the stress pattern of words with penultimate stress is preserved (e.g. *avokádo* → *ádo* 'avocado').

During all stages, children truncate syllables, complying with the prevalent word size at the relevant stage (see §2). The target syllables surviving truncation, and thus produced by the children, are usually those which are acoustically prominent, i.e. the final and the stressed ones (Echols and Newport 1992). However, when it comes to a competition between these two positions, the final syllable wins in both Hebrew and

Arabic (Ben-David 2014, Ben-David and Bat-El 2017 for Hebrew and Palestinian Arabic; Saleh et al. 2007 for Egyptian Arabic). The syllable strength hierarchy in language development is thus as follows (Ben-David and Bat-El 2017):

(12) Syllable strength hierarchy

Final Stressed	>	Final Unstressed	>	Non-final Stressed	>	Non-final Unstressed

Given the differences in the distribution of stress in Arabic and Hebrew, this could be a universal hierarchy, as in both languages children do fewer target-output alternations in final unstressed syllables than in non-final stressed ones.

To conclude, despite the differences in the distribution of the stress patterns in the ambient languages (predominance of final stress in Hebrew but penultimate in Arabic) and in the stress system in general (highly lexicalized in Hebrew vs. systematic in Arabic), children acquiring these two languages show similar tendencies: preference for non-final stress (supported by frequency in Arabic but not in Hebrew), and greater faithfulness to the final unstressed syllable relative to the non-final stressed one. Thus, both the trochaic bias and the strength hierarchy are universal.

4. Syllable structure

Arabic has more syllable types than Hebrew, mostly due to the vowel length contrast found in Arabic but not in Hebrew. Nevertheless, in both languages, CV is the most common syllable type, and CVC is next in line; together, these two syllable types constitute 86.6% in Hebrew (Asherov and Bat-El 2019), 76% in Lebanese Arabic (Hamdi et al. 2005), and 82.7% in Egyptian Arabic (Omar 1973). All other syllable types are relatively rare.

(13) Syllable types

	Hebrew	*Lebanese Arabic*	*Egyptian Arabic*
CV	**46.7%**	**43.2%**	**40.2%**
CVC	**39.9%**	**33.6%**	**42.5%**
V	5.0%	3.6%	——
VC	3.5%	0.3%	——
CCV	3.2%	3.0%	——
CVCC	1.1%	1.0%	0.2%
CCVC	0.5%	4.0%	——
VCC	0.1%	——	——
CVVC	——	5.3%	8.5%
CVV	——	5.2%	8.6%
CCVV	——	0.3%	——
CCVVC	——	1.0%	——

The distribution of syllable types in both Arabic and Hebrew complies with the universal markedness hierarchy. Syllables with onsets are less marked than syllables without onsets, and indeed, syllables with onsets comprise 91.4% of the syllables in Hebrew, 96.6% in Lebanese Arabic, and 100% in Egyptian Arabic. Similarly, simple onsets are less marked than complex onsets, and the distribution of complex onsets is indeed low, 3.7% in Hebrew (not including inflectionally suffixed words) and 8.3% in Lebanese Arabic (with higher percentages in Moroccan Arabic; Hamdi et al. 2005); Egyptian Arabic does not have complex onsets.

As for codas, syllables without codas are less marked than syllables with codas and we thus expect to find fewer syllables with codas. However, syllables without codas comprise just above 50% in Hebrew (54.9%) and Lebanese Arabic (55.3%), and even below 50% in Egyptian Arabic (48.8%). This universally unexpected distribution is due to a constraint requiring words to end in a consonant (McCarthy and Prince 1990b). This constraint reflects the joint effects of the role of consonants in lexical contrast (see §4.2 below) and the templatic nature of Semitic words (see §1), where the latter limits the number and type of syllables in the word and thus the number of consonants.

In accordance with both distribution and markedness, the first syllable types produced by children are with a simple onset (§4.1) and without a coda (§4.2). Complex syllable margins are acquired during later stages (§4.3).

4.1. Onsets

The first syllable produced by children is CV, where the onset consists of a single consonant (see §4.3 for complex onsets). This complies with universal preferences as well as language-specific distribution.

(14) The first syllable – CV

Hijazi Arabic			*Hebrew*		
Child	*Target*		*Child*	*Target*	
ba	dabbá:b	'bike'	pa	kafé	'coffee'
ti	há:ti	'give me'	da	jaldá	'girl'
kába	ʔáŋkab	'split	ka	kadúʁ	'ball'
búwa	mó:ja	'water'	tója	ʃókolad	'chocolate'

There is always an onset in monosyllabic productions, unless there is no such in the target (e.g. Hebrew *af* 'nose'). In polysyllabic productions, however, the initial target onset is often missing (e.g. Hebrew *mitá* → *itá* 'bed', *dúbi* → *úbi* 'teddy bear', *taʁnególet* → *agólet* 'hen'). This phenomenon is reported for Hebrew (Shaked 1990, Ben-David 2001, 2010, 2012, Karni 2012, Ben-David and Bat-El 2016) as well as other languages, such as Finnish (Savinainen-Makkonen 2000) and German (Grijzenhout and Joppen-Hellwig 2002), but rarely for Arabic.

Some studies report on glottal replacement (Saleh et al. 2007, Amayreh and Dyson 2009), whereby target consonants are replaced with a glottal stop regardless of their position in the word. Other studies (Al-Buainain et al. 2012 for Qatari Arabic, Alqattan 2015 for Kuwaiti Arabic) distinguish between glottal replacement (e.g. *ʕénæb* → *ʔénæm* 'grapes', *ʕátini* → *ʔátini* 'give me') and consonant deletion (e.g. *káli* → *áli* 'uncle', *sínbad* → *inbad* 'Sinbad'). Crucially, these two process target different consonants; while a glottal replaces mostly pharyngeals, deletion does not target a specific consonant. This distinction is actually made in Omar (1973), who claims that since the glottal stop is acquired late in word-medial and -final positions, its status as a phoneme in word initial position during the early stages of acquisition is debatable.

We argue, in the spirit of the latter view, that most cases that look like word initial glottal replacement are actually consonant deletion, where the word initial glottal is a mere phonetic effect. The argument is based on the peculiar distribution of a glottal stop in children's speech. According to Amayreh and Dyson (2009), the glottal stop is the most frequent consonant in the productions of children acquiring Jordanian Arabic. This distribution is not supported by the ambient language, where the glottal stop is forth in line in terms of frequency, after *l*, *m*, and *n*. Moreover, 80.7% (456/565) of the glottal stops in the children's productions are in word initial position,

compared with 16% (41/251) for *l*, 16% (26/167) for *n*, and 43% (100/230) for *m*. Amayreh and Dyson (2009) attribute the high frequency of the glottal stop to its function as an epenthetic consonant and a prefix, in particular in the definite article. However, according to this functional explanation, the glottal stop should be the most frequent consonant also in adults data.

As for target-output correspondence, Saleh et al. (2007) and Khattab and Al-Tamimi (2013) report that the most unfaithful position in the children's productions is word initial. This supports the consonant deletion view, which follows from the prosodic development of the word from right-to-left (§2), where the later position is acquired the less faithful it is. Saleh et al. (2007) also report that the most common process in children's productions is glottal replacements, whereby word initial consonant is replaced with a glottal stop. As in the case of the peculiarly high distribution of the glottal stop, also the distribution of glottal replacement is rather high compared with the other consonant: 133 cases of glottal replacement through the three age groups studied in Saleh et al., as oppose to 36 *t* replacement, 35 *l* replacement, and 22 *b* replacement. We argue that what is considered glottal replacement in initial position is, in most, cases consonant deletion; the glottal in this position is just a phonetic effect. This process is predicted by the right-to-left development of the prosodic word (see §2), whereby newly acquired positions are less faithful than the positions that were acquired earlier.

This argument gains further support from the qualitative behavior of the glottal stop. Consonant deletion (codas, word initial onsets) is usually due to prosodic development while substitution (replacement) is due to segmental development. In non-assimilatory segmental substitutions (i.e. not consonant harmony), a marked segment is substituted with a less marked one, and the substitution is relatively systematic to the extent that almost every segment (with the exception of rhotics) has one substituting counterpart (or two in case of affricates). In the studies arguing for word initial glottal replacement, the glottal stop seems to substitute many different segments, i.e. it is not the counterpart of any particular segment (e.g. HA *sámaka* → *ʔámaka* 'fish', *ħalá:wa* → *ʔalá:wa* 'candy', *maxádda* → *ʔadda* 'pillow', *bantˁaló:n* → *ʔaló:n* 'trousers'). We argue that this is not substitution but rather deletion, and therefore there is nothing peculiar in the children's target-output correspondences.

Word initial onset deletion is theoretically puzzling (Buckley 2003), since, as noted above, syllables with onsets are less marked and more frequent than syllables without onsets. This contradicts the general view that children's speech develops from the unmarked to the more marked (see review in Kager et al. 2004). However, we argue

that this is a simplification strategy in the path of the development of the prosodic word (§2).

Children expand the prosodic word from right-to-left, adding one syllable at a time. The addition of a new syllable goes in steps, first the nucleus, then the onset and finally the coda; e.g. Hebrew *ká* ⇒ *aká* ⇒ *maká* ⇒ *malká* 'queen'. Thus, during the process of word growth, there is a stage where initial onset is not produced (here *aká*). Moreover, each of these sub-syllabic units is not immediately filled with the target segment; first a copy of the following consonant (or vowel) appears, i.e. consonant (or vowel) harmony, and only then the target segment; e.g. Hebrew *ka* ⇒ *aká* ⇒ ***k***aká ⇒ *maká* 'hit'. This developmental path explains the vulnerability of word initial position in children's productions. According to Saleh et al. (2007), this position displays the lowest percentages of correct productions compared to word medial and word final positions. This decrease in segmental accuracy during the expansion of the prosodic word reflects a "trade-off" effect, whereby children simplify already acquired structures when they produce new ones (Ferguson and Farwell 1975, Garnica and Edwards 1977, Stemberger et al. 1999, Bat-El 2012, Becker 2012).

(15) Stages in the acquisition of a simple onset

	Onset deletion	> *Onset copying*	> *Target onset*	
HEB	ipúʁ	pipúʁ	sipúʁ	'story'
	emalá	memalá	nemalá	'ant'
HA	ídu	dídu	sídu	'grandfather'
	ó:ka	kó:ka	ʃó:ka	'fork'

As shown in (15), the detailed developmental path is not due to a late acquisition of a particular segment, but rather to the cumulative complexity involved in adding not only a segment but also the prosodic position that hosts the segment.

4.2. Codas

Syllables with codas are universally marked, but the frequency of final codas in both Arabic and Hebrew is rather high (see (12)). Consequently, children acquiring Arabic and Hebrew produce final codas relatively early compared with children acquiring Greek (Kappa 2002) and European Portuguese (Freitas et al. 2001), where final codas are not as common.

Regardless of frequency, the developmental path follows the markedness hierarchy, where syllables without codas are produced before syllables with codas, sometimes in stressed syllables before unstressed ones (Kaltum-Roizman 2008, Gishri 2009). This

order is manifested mostly in polysyllabic productions, since monosyllabic productions tend to preserve their codas, as shown in Abdoh's (2010) study of three age groups of children acquiring Hijazi Arabic.

(16) The distribution of syllable types in children's productions

			1;0-1; 3	1;4-1;6	1;7-1;9
a.	Monosyllabic	CV	10%	3%	0.9%
		CV:	2.2%	1.6%	0.7%
		CVC	19.7%	14.1%	8.8%
		CV:C	7.0%	13.1%	11.7%
b.	Disyllabic	CV.CV	29.1%	17.6%	8.3%
		CV:CV	10.6%	14.0%	13.1%
		CVC.CV	17.6%	19.8%	15.6%
		CV.**CVC**		2.3%	6.8%
		CV:.**CV:C**		3.0%	6.5%
		CV:.**CVC**		0.5%	1.2%
		CVC.**CVC**		2.2%	6.1%

In monosyllabic productions (16a), syllables with codas (CVC, CV:C) are dominant in all three age groups. Taking into consideration vowel length contrast, children produce more CVC than CV words, and more CV:C words than CV: words. In contrast, in disyllabic productions (16b), the percentage of syllables without codas is relatively high.

One may suggest that the coda in monosyllabic words is preserved in compliance with the MINIMAL WORD constraint (see §2.1). However, this constraint can be perfectly satisfied with CV: words, since long vowels are bimoraic. Indeed, coda deletion is often accompanied with compensatory lengthening, but this occurs in both monosyllabic and disyllabic productions (e.g. KW *tˤi**g*** → *ti:* 'hit', *ɣassí**l*** → *kəssé:* 'wash'; HA *ʔaki**l*** → *ʔaki:* 'food', *líʕba* → *lí:ba* 'toy', *d͡ʒázma* → *tá:ta* 'shoes'), thus cannot be attributed to the MINIMAL WORD constraint. We propose that final codas in monosyllabic productions contribute to the enhancement of lexical contrast, as consonants are known for their lexical value not only in adults' (Nespor et al. 2003) but also in children's grammars (Poltrock and Nazzi 2015).

The role of codas in contrast enhancement in monosyllabic productions is also found in the acquisition of Hebrew. During the pre-MW stage (see §2.1), words are not only monosyllabic but also codaless. However, if the target word is onsetless, i.e. VC, the coda is produced (Ben-David 2001, Ben-David and Bat-El 2016). For example, during the period where *kaf* 'spoon' is produced as *ka*, the target word *af* 'nose' is produced faithfully as *af*, maintaining the only lexically contrastive segment in the

word. The requirement for at least one consonant in the word does not hold in atypical development of Hebrew (Adi-Bensaid 2006, Adi-Bensaid and Bat-El 2004, Adi-Bensaid and Tubul-Lavy 2009), where children often produce consonant-free words (e.g. *e* ← *en* 'no more', *o* ← *ʃaón* 'watch', *aó* ← *adóm* 'red', *aó* ← *kaχól* 'blue'). The only consonant-free word in typical development of Hebrew is *o* ← *oʁ* 'light', where the coda is not produced for segmental reasons, due to the later acquisition of *ʁ*.

In terms of stages of coda development, Hebrew-acquiring children first produce word final codas, and only later word medial codas: *babú* ⇒ *babúk* ⇒ *bakbúk* 'bottle'. As can be read from (16b), Arabic-acquiring children seem to produce medial codas before final codas, as CVC.CV is the only polysyllabic word-type with coda produced by the youngest age group in Abdoh's (2010). However, in all these CVC.CV words there is a medial geminate (e.g. HA *kálba* → *kábba* 'dog', *ʃúrba* → *súbba* 'soup'), which means that the mora of the coda is produced but not the segment itself. Thus, on the segmental level, Arabic-acquiring children produce word final codas before word medial codas (e.g. KA *ʔárnəb* → *ʔánəb* 'rabbit', *dɪʃdá:ʃə* → *dɪdá:ʃə* 'Arab men's dress'), just like Hebrew-acquiring children, but on the moraic level, word medial codas appear before word final codas: *mutá:* ⇒ *muttá:* ⇒ *muttá:ħ* ⇒ *muftá:ħ* 'keys' (Ammar 2012, Alqattan 2015, Ayyad 2011).

Medial geminates in Arabic are produced rather early (Abdoh 2011, Khattab and Al-Tamimi 2013), to the extent that a singleton may be replaced by a geminate (e.g. Lebanese Arabic *bá:ba* → *bæbbæ:* 'daddy', *táʕa* → *dáʕʕah* 'come here'). This early production can be attributed to contrastive function of geminates the lexicon (Khattab and Al-Tamimi 2014, 2015). Moreover, Khattab and Al-Tamimi (2014) report that before the geminate-singleton contrast is apparent in the children's productions, the length of the consonants (and the vowels) is similar to the length of geminates (and long vowels) in later stages.

As with onsets (see (15)), the development of medial codas proceeds on two tiers, prosodic and the segmental. First, the relevant position is missing and consequently also the segment that hosts it; then the prosodic position appears without the target segment, and this position is filled with an existing segment, usually consonant, yielding a geminate, but sometimes also a long vowel (e.g. HA *líʕba* → *lí:ba* 'toy'). As argued in Bat-El (2012) for Hebrew word final codas, cumulative complexity enforces the detailed stages of development with the addition of one new structural element at a time – first the position and then the segment.

4.3. Complex syllable margins

Complex syllable margins are universally marked and their distribution within a language is lower than that of a singleton; consequently, they are acquired relatively late in both Arabic and Hebrew (at roughly the age of 4). Before they are faithfully produced, complex syllable margins undergo simplification, usually via consonant deletion, also known as cluster reduction (Ben-David 2001, Ayyad 2011, Abdoh 2010, Bloch 2011, Alqattan 2015, Ben-David and Bat-El 2016).

(17) Complex margin reduction

		Child	*Target*			*Child*	*Target*	
a. Onset:	KA	da:k	dla:q	'sock'	HEB	gída	glída	'ice cream'
		ʃu:m	xʃu:m	'noses'		χína	tχína	'tahini'
		du:r	d͡ʒdu:r	'pots'		miχá	smiχá	'blanket'
b. Coda:	HA	kab	kalb	'dog'		tos	tost	'toast'
		bin	bint	'girl'		kos	kʁoks	'crocks shoes'
		tat	taħt	'under'		tʃip	tʃips	'potato chips'

Other, rather rare strategies to amend complex margins include epenthesis, as documented for complex onsets in Hebrew (e.g. *gviná* → *geviná* 'cheese') and Kuwaiti Arabic (e.g. *brú:ħi* → *bərú:hi* 'alone 1.POSS'), as well as complex codas in Hijazi Arabic (e.g. *baħr* → *baħar* 'sea'). Even rarer are coalescence (e.g. *gviná* → *biná* 'cheese') and vowel-consonant metathesis (e.g. *gviná* → *givná* 'cheese') documented for Hebrew.

As in the case of medial coda development (see §4.2), there is a stage where complex codas in Arabic are replaced with a geminate (e.g. Cairene Arabic *kalb* → *tabb* 'dog', *ħabl* → *ħabb* 'rope', *ʔimħ* → *ʔimm* 'wheat', *ʃiribt* → *ʔitt* 'I drank'). Here again, first the position is added and then the segment (*ka* ⇒ *kab* ⇒ *kabb* ⇒ *kalb*). Ragheb and Davis (2014), attend to the role of the segment in the development of complex codas. Due to the later acquisition of liquids, when complex codas with nasals and pharyngeal are produced faithfully complex codas with liquids are produced with geminates.

(18) Complex coda development (Cairene Arabic; Ragheb and Davis 2014)

		Child	*Target*	
Gemination:	C_1 = *l*	tabb	kalb	'dog'
	C_2 = *l*	tabb	ħabl	'rope'
	C_1 = *r*	funn	furn	'oven'
Faithful:	C_1 = nasal	mint	bint	'girl'
		sans	ʃams	'sun'
	C_1 = pharyngeal	ʕuʔd	ʕuʔd	'necklace'
		taħt	taħt	'under'

It should be noted that the stage of gemination in complex codas is not reported for other languages, possibly due to the absence of geminates in the target language. This may suggest that at least some of the errors children make in the course of development have to be licit structures in the ambient language.

5. Concluding remarks

In this paper, we trailed the paths that children take in the course of the prosodic development towards target words in Arabic and Hebrew. As these two languages are phonologically different (despite their genetic relation), the study of their acquisition contributes to the debate regarding the sources of linguistic knowledge.

There are two opposing, though partially overlapping approaches to language acquisition and language knowledge in general, the usage-based approach (Tomasello 2003) and Chomsky's UG (universal grammar) approach (see review in Yang 2004). 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 that allows children to draw quantitative generalizations from the input. For the generative approach, the general cognitive toolbox includes a toolbox specific to linguistic knowledge where universal principles are stored.

When it comes to the acquisition of phonology, the two approaches often make the same predictions. Universal markedness constraints are often phonetically grounded and typologically supported by inter- and intra-language distributional frequencies. For example, CV syllables are universally unmarked and also more frequent in both Hebrew and Arabic and thus both frequency and universal mrakedness correctly predict that CV would be the first syllable children produce (see §3). However, some of the phenomena discussed in this paper reveal language-specific effects, while others reflect the role of universal principles.

A clear language-specific effect has been show by the replacement of consonant sequences with geminates, in word medial and word final positions (see §4.2 and §4.3 respectively). This phenomenon is found only in the speech of Arabic-acquiring children and not in that of Hebrew-acquiring children, since Hebrew, unlike Arabic, does not have geminates. As geminates are marked relative to singletons, their production is contingent upon positive evidence from the ambient language.

A clear effect of universal principles has been shown by the distribution of stress in the children's speech (see §2). Hebrew exhibits a rather rare case of a conflict between frequency and markedness, where the marked final stress enjoys higher frequency. Following universal markedness, the unmarked and less frequent penultimate stress is the first to appear in the early productions of Hebrew acquiring children, as much as in the Arabic acquiring children where stress is predominantly penultimate. In addition, regardless of the differences in the distribution of stress, children acquiring both Hebrew and Arabic follow the same universal strength hierarchy.

Children have data-handling and hypothesis formulating abilities (Chomsky 1959), which are argued to include statistical learning (Saffran et al. 1996, Pierrehumber 2003). However, when children do not get sufficient input (during very early stages), or when the input is not reliable (mostly due to a great degree of irregularity), *they resort to universal principles*, *which are always at their disposal*.

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