On the L1 development of final consonant clusters in Cairene Arabic*

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This study presents data on the first language development of final consonant cluster acquisition in Cairene Arabic. We compare the production of final consonant clusters of two siblings (an older brother and a younger sister) acquiring Cairene Arabic in a monolingual setting when both were 2 years, 8 months (2;8). Since one child had more target-appropriate clusters than the other at that age, we get a glimpse of the developmental path of final consonant cluster acquisition in Cairene Arabic. Our findings include that pharyngeal-initial final clusters are acquired early and that gemination is the common "repair" strategy for clusters not yet acquired. We conclude by relating our findings to theories regarding the nature of first language phonological acquisition.

Keywords: Phonology, child language acquisition, consonant clusters, Cairene Arabic, geminates.

1. Introduction

While there have been an increasing number of studies on Arabic phonological acquisition, certain areas of such research have not been addressed. Many of the

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available studies focus on the normative ages of acquisition of consonants (e.g., Amayreh, 1994, 2003; Amayreh and Dyson, 1998; Omar, 1973; Saleh, Shoeib, Hegazi and Ali, 2007). Few studies, though, have examined the acquisition of consonant clusters. The only documented work on the acquisition of final consonant clusters in any Arabic dialect that we are aware of is our own preliminary (unpublished) work on one child acquiring Cairene Arabic (Ragheb, 2010; Ragheb and Davis, 2010). The aim of the current paper is to present and describe data collected from two children who are siblings (an older brother and a younger sister) acquiring Cairene Arabic (CA) in a monolingual setting when both were 2 years, 8 months (2;8) with a focus on their final consonant cluster acquisition. Because these two children were at somewhat different stages of cluster development, the comparison of the two children allows us to begin to understand the developmental path of cluster acquisition in Arabic. An additional aim of our paper is to relate our findings to the larger debate in acquisitional phonology as to the very nature of the acquisition process: One view holds that phonological acquisition is essentially reducible to articulatory development reflecting performance factors and not the phonological grammar (Hale and Reiss, 2008; Blevins, 2009), while a competing view maintains that phonological development reflects language competence that entails knowledge of the phonological structure of the language being acquired (e.g., Fikkert, 1994; Demuth, 1996; see also Rose and Inkelas, 2011 for a recent overview).

This paper proceeds as follows: in Section 2, we present background briefly mentioning some previous work on Arabic phonological acquisition and relevant information on Cairene Arabic phonology. In Section 3, we summarize and discuss our preliminary findings of the production of final clusters in CA of one child at the age of 2;8. In Section 4, we present data on final cluster acquisition from a second child, the younger sibling of the first, acquiring CA when she was also at the age of 2;8. In Section 5, we outline a predicted trajectory or developmental path for consonant cluster acquisition in CA, based on the described and analyzed production of the two children. We are able to get a glimpse at the trajectory since one child had more target-appropriate clusters than the other, even though both were at the same age when data were collected. In Section 6, we discuss the major findings of our work as it relates to the ongoing debate on the nature of L1 phonological acquisition.

2. Background

In this Section, we briefly discuss previous work on Arabic acquisitional phonology and then present some aspects of Cairene Arabic phonology that are relevant for our current study.

2.1 Arabic acquisitional phonology

As both Dyson and Amayreh (2007) and Khattab (2007) specifically note, there is a lack of studies on the acquisition of consonant clusters in Arabic. Nonetheless, there have been observations such as that of Dyson and Amayreh (2000) that there are low percentages of coda deletion or consonant cluster simplification in normally developing 2–4 year olds (based on Jordanian Arabic). These observations are consistent with a finding of Khattab and Al-Tamimi (2011) who note that the Lebanese Arabic children of their study did not go through a CV stage or even a CVC stage. Their first content words were already minimally bimoraic (e.g., CVCC or CVVC). What emerges from these reports on Jordanian and Lebanese phonological acquisition is the absence of the simple deletion of a consonant to avoid complex syllables. By simple deletion, we mean deletion that has no noticeable compensatory effects such as gemination or vowel lengthening. This differs from English phonological acquisition where the simple deletion of a consonant to avoid complexity in syllable structure is commonly observed (McLeod, van Doorn and Reed, 2002).

Most previous work on the acquisitional phonology of Arabic dialects has largely focused on examining the age of the mastery of production for each consonant, distinguishing between consonants that are acquired early from those that are acquired late (cf. for Jordanian Arabic: Amayreh, 1994, 2003; Amayreh and Dyson, 1998; for Egyptian Arabic: Omar, 1973 and Saleh et al., 2007). For example, with respect to Jordanian Arabic, Amayreh (1994, 2003) and Amayreh and Dyson (1998) studied the ages of acquisition of consonants concentrating on which individual consonants were acquired early and which were acquired later. In a similar study of Egyptian Arabic by Saleh et al. (2007), 30 Cairene-speaking children ranging in age between 12 to 30 months were examined. While Saleh et al. did not provide a detailed description on consonant cluster development, they report the occurrence of glottal stop replacement (that is, the use of a glottal stop as replacement for other consonants), which has been similarly observed in our study, too.

A final report that we will mention, by Ayyad and Bernhardt (2009), presents data from a normally developing (bilingual) child aged two years, four months (2;4) who was acquiring Kuwaiti Arabic in an English-speaking environment (North America). Based on the production of 38 words, the child had already acquired labials, dorsals, the uvular and pharyngeal fricatives and the emphatic /tˤ/ with 100% accuracy. The child had not yet acquired the other emphatics, the interdentals, /ʃ/, and /r/. Moreover, the data analysis shows that the child's productions included medial geminates and some consonant clusters in all positions (initially, medially, and finally). While this study is in some ways relevant for our own work, since we also observe the late acquisition of /r/ and the early acquisition of geminates and pharyngeal fricatives, the data did not report on certain structures such as words with final geminates. Also, Kuwaiti Arabic does not have the range of final consonant cluster types that are witnessed in Cairene Arabic.

2.2 Consonant clusters in Cairene Arabic

One of the main characteristics of Cairene Arabic in comparison to other Arabic dialects is that it allows for final clusters consisting of any two consonant phonemes. While a word-final syllable in CA can end in (maximally) two consonants, a non-final syllable can end in at most one consonant. On the other hand, CA lacks word-initial and syllable-initial consonant clusters generally, although [kw] occurs marginally in words like [kwajjis] 'good'. Examples of final clusters are given in (1). Cairene Arabic allows word-final clusters of any sonority profile (falling, level, rising). In addition, words with final geminates are common, such as [nusˁsˁ] 'half' and [sitt] 'woman'. (Note, transcriptions are essentially phonemic: low-level allophonic changes are not indicated.)

(1) Final consonant clusters in Cairene Arabic

Cairene	Gloss
a. bint	daughter
b. ʃams	sun
c. ʔism	name
d. ʔult	I said
e. ʔatl	killing
f. ʕaks	opposite
g. misk	musk
h. ʕabd	slave
i. kidb	lies
j. masˁr	Egypt
k. ʔursˁ	tablet, pill

The data in (1) a., b., d., and k. exemplify words where the final consonant cluster has falling sonority going from a sonorant consonant into an obstruent. Such final clusters are fairly common in Arabic dialects. The final clusters in (1) c., e., and j. show rising sonority with an obstruent followed by a sonorant. In many dialects, an epenthetic vowel would occur at least optionally to break up such clusters so that these words would be pronounced as two syllables. In CA, the words in (1) c., e., and j. are pronounced as monosyllables with some degree of phonetic devoicing of the word-final sonorant. They cannot be pronounced with an epenthetic vowel, not even optionally. The words in (1) f.–i. end in two obstruents and can be considered as displaying level sonority of the final cluster. Again, such words are pronounced as single syllables.

Our study focuses on consonant cluster development in children acquiring CA. Given the range of final consonant clusters in CA as exemplified in (1) along with the difficulty that children acquiring English have in mastering final clusters (McLeod et al., 2002), it could be hypothesized that final clusters would be difficult for children acquiring CA to master. Moreover, if they are difficult to master, a sonority effect can be assumed in which clusters of falling sonority should be more easily mastered (i.e., occur earlier in acquisition) than clusters of rising sonority, given that they are much more common across languages. Furthermore, it could be hypothesized that typically developing CA-speaking children might delete one consonant of the final cluster or insert a vowel into the cluster, similar to typically developing English-speaking children. Before turning to our acquisition data that bear on these matters, we briefly discuss the prosodic nature of CA word-final syllables since this will be of importance in understanding the acquisition data.

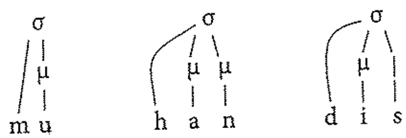
The prosodic nature of word-final syllables in CA is reflected by the stress pattern of the language. Any word in which the final syllable ends in two consonants will have stress on the final syllable as exemplified in (2) a. Similarly, any word that ends in a geminate consonant will have final stress as indicated in (2) b. On the other hand, a word that ends in a CVC syllable with a single word-final consonant does not have stress on the final syllable. It will normally have stress on the penultimate syllable (2) c. or the antepenultimate syllable in longer words (2) d. (specifically when the antepenultimate syllable is CV or light), unless the penultimate syllable is heavy (e.g., CVC), in which case the penultimate syllable attracts stress as in (2) e.

(2) Representative stress patterns of Cairene Arabic (period indicates syllable boundary, the stress syllable is in bold)

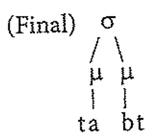
a.	ka.**tabt**	'I wrote'
b.	ʔa.**xaff**	'lightest'
c.	**ka**.tab	'he wrote'
d.	**ku**.tu.bak	'your (masc.) books'
e.	mu.**han**.dis	'engineer'

The CA stress pattern, especially as it relates to final syllables, can be understood through the notions of moraic weight and final consonant extraprosodicity (see Hayes, 1995 and Watson, 2002 concerning CA). Essentially, a coda consonant (but not a word-final consonant) adds weight to the syllable. That is, a coda consonant is moraic except if it is at the end of the word. Given that short vowels also add a mora to the syllable, we see that in comparing (2) a. with (2) c., a final syllable receives stress if it is bimoraic. If the final syllable is not bimoraic, then the penultimate syllable receives stress if it is bimoraic, as illustrated by a comparison between (2) e. and d. Words ending in a geminate always receive stress on the final syllable ((2) b.) thus suggesting that a geminate consonant always adds a mora to the syllable (see Watson, 2002 on this point). In (3), the mora structure of the word [muhandis] 'engineer' is illustrated, and in (4) and (5) we show the mora structure of the final syllable of [katabt] 'I wrote' and [ʔa.xaff] 'lightest', respectively.

(3) Moraic representation of [mu.**han**.dis] 'engineer' (σ indicates syllable; μ indicates mora)

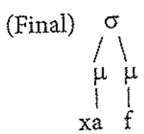


(4) Moraic representation[1] of the final syllable of [ka.**tabt**] 'I wrote'



(bimoraic, receives stress)

(5) Moraic structure of the final syllable of [ʔa.**xaff**] 'lightest'



(bimoraic, receives stress)

The examples in (2) and the illustrations in (3)–(5) show that a final syllable receives stress if it is bimoraic. What will be important for our study is the parallel prosodic structure shown in (4) and (5) between words ending in two consonants and a final geminate. Both types of words end in a bimoraic syllable that attracts stress. We now turn to our acquisition data.

3. Child 1: Word list MG

In this section we report on the data and observations from our previous (unpublished) study (Ragheb, 2010; Ragheb and Davis, 2010). For that study, the first author elicited data in July 2008 from one male child, MG, aged two years, 8 months (2;8), who was typically developing and was acquiring Cairene Arabic in a monolingual environment in Cairo. Data were gathered using pictures that elicited word responses from a pre-designed word-list (focused on clusters) and spontaneous speech, which was recorded and later transcribed. The pictures used to gather

1. For (4) and (5), only the moraic elements are shown.

data were specifically chosen to elicit target words ending in consonant clusters.[2] The first author used a book that had different pictures or scenes in it and which was generally aimed at increasing a child's vocabulary. The researcher would ask MG to identify or search for certain objects, animals, and actions in the book in order to elicit the target words. Another task that relied more on spontaneous speech involved the researcher and MG engaging in telling stories or recounting certain events. Data were collected at multiple times over a one-month period, resulting in 10 sessions of about one hour in length. In (6), we see a representative sample of MG's production of word-final consonant clusters. The first column in (6) shows the target adult pronunciation of the CA word, and the second column demonstrates MG's pronunciation of the target CA word.

(6) A representative sample of MG's pronunciation of CA target words with final consonant clusters

Target pronunciation	MG's pronunciation	Gloss
a. nusˤsˤ	ʔusˤsˤ	half
b. ward	wadd	flowers
c. bint	bitt	girl
d. kalb	kabb	dog
e. ʃiribt	ʔitt	I drank
f. miʃtˤ	ʔitt	comb
g. naml	ʔall	ants
h. ħabl	ʔall	rope
i. ʔism/ʔismu/ʔismi	ʔimm/ʔimmu/ʔimmi	name/his name/ my name
j. malħ	ʔall	salt
k. ʔamħ	ʔamm	wheat
l. taħt	taħt	under
m. baħr	baħl	sea
n. ʃaʕr/ʃaʕru	saʕl/saʕlu	hair/his hair

2. In the process of elicitation, multiple tokens of each target words were collected over the different recording sessions. The spontaneous speech recorded also included multiple tokens of different target words over different points in time. The researchers only included for analysis those tokens that the children produced without any help from adults. Any tokens resulting from repetition after an adult modeling were disregarded, as imitation is not a reliable method of getting at a child's phonological knowledge. The data presented here for both children constitute a representative sample of the gathered data. The initial probe (word list) both changed and expanded according to the individual knowledge of the child. For example, the word [ʔatˤr], 'train' was initially on the list, but one of the children called it by another name, thus resulting in replacing this word by another target word with a final CC cluster that the child knew.

The present paper is focused on the production of final clusters, so we will not discuss MG's use of onset glottal replacement, especially common in words where the final clusters are more marked. (6) a. shows that MG had target-appropriate final geminates. These seem to be acquired very early in the acquisition process. (6) b.–d. shows that in a target word where the final cluster has falling sonority, MG deleted the first consonant of the cluster and geminated the second (i.e., the word-final consonant geminates). Similarly, in words where the target final cluster has level sonority (as in the obstruent clusters of (6) e.–f.) or rising sonority (as in (6) g.–i.), MG deleted the first consonant of the cluster and geminated the second or final consonant. Thus, (6) b.–i. shows no effect of the level of sonority on target cluster production. However, in producing pharyngeal final target clusters, a different pattern emerged, as illustrated in (6) j.–k. Here, MG deleted the final pharyngeal consonant and geminated the first consonant of the cluster. Importantly, from our more comprehensive set of data on MG at 2 years 8 months, we know that he did not have geminate pharyngeals in his system (though he clearly had pharyngeal consonants as singletons). Consequently, final gemination for the target words in (6) j.–k. was not a possible outcome. He nonetheless still geminated, but it was the initial consonant of the cluster that geminated rather than the final. Thus, the data in (6) b.–k. show a pattern of gemination for final target clusters. It is interesting to note that such a gemination pattern has not been reported as a manifestation of target final clusters in English L1 acquisition.

We now consider the data in (6) l.–n. These CA words contain final consonant clusters where the first consonant of the cluster is a pharyngeal fricative and the second is either an obstruent or a sonorant. Essentially, MG produced these clusters as target-appropriate.[3] This is most clearly seen with the data item in (6) l., /taħt/, which MG pronounced correctly. (6) m.–n. are almost pronounced target appropriately, with the word-final /r/ being pronounced as [l]. However, a more complete examination of MG's data shows that he had not acquired /r/ at this stage and normally substituted [l] for target-appropriate /r/. Consequently, we conclude that MG acquired a final cluster in (6) m.–n. where the first consonant is a pharyngeal and the second is a liquid.

MG's final consonant cluster data in (6) raises two issues. First, assuming that MG's language acquisition was normal, why do the first types of final clusters acquired include a pharyngeal-initial cluster? Is this related to sonority? Second, why is final gemination the common "repair" strategy for clusters that are not yet

3. It is crucial to point out that, with both children, the consonant clusters produced target-appropriately were done so every time they were elicited or when they occurred in spontaneous speech. Thus, even with the most stringent of measures of L1 acquisition, they are considered to have been acquired.

acquired appropriately, especially in light of the fact that this strategy has not been noted generally in the literature on L1 final cluster acquisition? In considering the first issue, it is important to mention that phonetic work on Egyptian Arabic by Elgendy (2001) has shown that pharyngeal fricatives have phonetic characteristics of glides. This characterization of pharyngeals has also been espoused by McCarthy (1994) and Halle (1995). Given this, we maintain that the final clusters acquired earliest by MG are those in which the first consonant of the cluster has the highest sonority, namely a glide. It should be noted that while CA has both the palatal glide /j/ and the labiovelar glide /w/, they do not appear in consonant clusters for independent reasons: CA underlying sequences with final glide clusters such as /bajt/ 'house' and /lawn/ 'color' surface as [beet] and [loon], respectively, because of the independent process of monophthongization. (See Youssef, 2010, for specific argumentation justifying that [ee] and [oo] derive from /aj/ and /aw/, respectively, in a synchronic analysis of the phonology of CA). Thus, we maintain that MG's final cluster acquisition is constrained by sonority preferences in that the first member of a final cluster should be of highest sonority so that there will be a sonority fall in the first clusters acquired. In other words, while CA final clusters often violate preferred sonority sequencing (i.e., clusters can be of rising sonority), the L1 acquisition of such clusters may reflect markedness considerations whereby preferred final clusters with falling sonority are acquired earlier.

With respect to the second issue as to why MG always manifested final gemination for the clusters that were not yet acquired target appropriately as seen by the data shown in (6) b.–k., we have argued in our previous work (Ragheb, 2010; Ragheb and Davis, 2010) that gemination reflected MG's knowledge of the prosodic structure of Cairene Arabic, since by gemination MG was able to preserve the prosodic structure (i.e., mora structure) of the target word without having to pronounce two adjacent consonants that have two different articulations. Recall from the discussion in Section 2 that, as seen in (4), a final syllable that ends in a consonant cluster (or a monosyllabic word of the shape CVCC) is bimoraic. Further, as seen in (5), a final syllable that ends in a geminate is also bimoraic. This means, as we show in (7) below, that both the target pronunciation of words like [bint] in (6) c. and MG's pronunciation of it as [bitt] have the same prosodic structure.

(7) Moraic structure of target syllable [bint] and MG's pronunciation of it as [bitt]

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Target [bint] 'girl': a. Syllable            b. MG: Syllable
                          / \                         / \
                         μ   μ                       μ   μ
                         |   |                       |   |
                         bi  nt (bimoraic)           bi  t [bitt] (bimoraic)
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Note that simply deleting one of the final consonants without geminating is problematic because the final syllable would be prosodically different from the target as shown in (8).

(8) Mora structure of target [bint] being pronounced as [bit]
[bint] 'girl' (Final)Syllable

```
        |
        μ
        |
       b i t
```

(monomoraic, no preservation of prosodic structure)

Moreover, it should be noted that CA lacks content words that are CVC, so the potential pronunciation of [bit] for target [bint] 'girl' would be in violation of the phonotactics of the language. Consequently, MG's gemination reflected his tacit knowledge of the prosodic structure of CA. By gemination he preserved the prosodic structure of the target word. MG's tendency to geminate the word-final consonant (as opposed to the first consonant of the final cluster) may just reflect the saliency of the right edge of the word. We now consider a second child whose cluster data provide more insight into the developmental path of cluster acquisition in CA.

4. Child 2: RG

In this Section, we report on the data and observations of a second child, a female, RG, also 2 years 8 months of age (2;8) at the time of data collection, who is acquiring Cairene Arabic as her L1 in a monolingual setting. She is the sister of MG, three years younger. In the course of 12 sessions during May 2011, the first author elicited target data through several picture-naming tasks, as well as through spontaneous speech. The data collection procedure and instruments were similar to those in MG's study, except for allocation of more time to spontaneous speech production. Thus, the same book was used, and RG was asked to perform the same tasks (e.g., search for, or identify, an object, animal, etc.). Data were recorded and then broadly (i.e., phonemically) transcribed.

In (9), we present a representative sample of RG's production of word-final consonant clusters. The first column shows the target adult pronunciation of the CA word and the second column indicates RG's pronunciation of the target CA word. We can initially observe from RG's data in (9) that she has produced more types of target-appropriate final clusters in comparison to the final clusters produced by MG at the same chronological age as was seen in (6).

(9) A representative sample of RG's pronunciation of CA target words with final consonant clusters

Target Pronunciation	RG's pronunciation	Gloss
a. taħt	taħt	under
b. baħr	baħd	sea
c. ʃibiʕt	ʃibaʕt	I'm full
d. ʃaʕr	ʃaʕd	hair
e. ʕuʔd	ʕuʔd	necklace
f. issubħ	issuħħ	(in) the morning
g. malħ	laħħ	salt
h. jaʕʕ	jaʕʕ	yuck!
i. ʃams	sans	sun
j. kinz	tinz	treasure
k. bint	mint	girl
l. miʃtˤ	miʃtˤ	comb
m. masˤr	masˤd	Egypt
n. ʔirʃ	ʔiʃʃ	shark
o. ʔird	ʔidd	monkey
p. durg	dudd	drawers
q. furn	funn	oven
r. maltˤ	matˤtˤ	naked/scantily dressed
s. kalb	tabb	a dog
t. libs	liss (i) beet, liss	clothes, indoor clothes
u. ʔakl	ʔatt	food
v. naml	namm	ants
w. ħabl	ħabb	rope
x. ʔismu (ʔism)	ʔissu (ʔiss)	his name (name)

Examination of the data in (9) reveals the following observations on RG's final consonant cluster development. First, as a general observation, RG had target appropriate word-final geminates. Unlike MG, this also included geminate pharyngeals, as indicated by the target appropriate form in (9) h. Second, like her brother at this age, RG had target-appropriate pharyngeal-initial consonant clusters in word-final position, as seen in (9) a.–e. This is most clearly seen in data items (9) a., c., and e., where the target cluster is a pharyngeal followed by an obstruent. The target pharyngeal-rhotic final clusters in (9) b. and d. were realized with the rhotic consonant as [d]. It should be noted that at this stage, RG did not have /r/ in any position. While MG frequently substituted [l] for target /r/, we observed that RG did not have [l] in coda position; thus she substituted [d] for target /r/ in (9) b. and (9) d. We consider her pronunciation of the clusters in (9) b. and d. as target-appropriate in the sense that she pronounces two different consonants in a pharyngeal-initial final cluster, with the first consonant being accurately produced as a pharyngeal.

In addition to the pharyngeal-initial clusters, RG had more target-appropriate final clusters than MG at this age. This includes Nasal + Obstruent final clusters as in (9) j.–k., but note instances of non-target-appropriate place assimilation as in (9) i., where the bilabial nasal of /ʃams/ 'sun' was assimilated in RG's pronunciation to the coronality of the word-final /s/, resulting in [sans]. It should be noted that Nasal + Sonorant clusters were not yet acquired target-appropriately by RG at this stage, as demonstrated by her pronunciation of the target form [naml] 'ants' in (9) v. as [namm] with gemination. Also, as indicated in (9) l.–m., Sibilant + Obstruent final clusters were also target-appropriate. This is clearly seen in (9) l., but can also be observed in 9 m., where the word-final rhotic was treated as the obstruent [d], just as in (9) b. and d. This should be compared with (9) x., where the rising sonority Sibilant + Nasal cluster shows gemination in RG's pronunciation rather than the target appropriate sequence of consonants. To summarize, at 2 years 8 months, RG had acquired three types of final clusters target appropriately: pharyngeal-initial final clusters, Nasal + Obstruent clusters, and Sibilant + Obstruent clusters.

With respect to the other clusters shown in (9) that RG has not yet acquired target appropriately, RG displayed a gemination strategy similar to her brother for the target final clusters, though her specific pattern of gemination was somewhat more complicated. In falling and same sonority clusters as in (9) n.–t., which had not yet been acquired target appropriately, RG deleted the first consonant of the final cluster, geminating the second. This should be contrasted with rising sonority final clusters as exemplified in (9) u.–x., where RG deleted the final consonant of the cluster, geminating the first. The specific example of target [ʔakl] 'food' in (9) u., which RG realized as [ʔatt], reflected her independent manifestation of velar stop fronting where the velar stops /k/ and /g/ were realized as coronal stops. This can be seen by her pronunciation of target /kinz/ 'treasure' in (9) j. as [tinz]. The important observation is that, like MG, RG showed gemination as the "repair" strategy for final clusters that had not yet been acquired target-appropriately. We maintain that this reflected her tacit knowledge of the prosodic (i.e., moraic) structure of Cairene Arabic, as was shown in (7) with respect to MG's pattern of gemination. Moreover, RG's choice of which consonant to geminate for the most part reflected the sonority of the consonant, namely, that the consonant with lower sonority in the cluster tends to geminate. This is most clearly seen in (9) n.–s., where gemination is applied to the lower sonority final consonant in the cluster, and in (9) v.–x., where the initial consonants of the clusters have lower sonority

and are geminated. The data item (9) t. seems to suggest that in final clusters consisting of two obstruents, it is the second one that geminates. The only exceptions to this pattern of gemination are the clusters in (9) f. and g. that end in pharyngeal consonants. Since these clusters have rising sonority, they were not yet acquired target-appropriately by RG. Yet she geminated the more sonorant pharyngeal consonant, rather than the preceding consonant. This perhaps has to do with the saliency of pharyngeals in CA (or, restated from an optimality-theoretic perspective, the constraint requiring faithfulness to pharyngeal consonants was highly-ranked in her system).

Having presented the final consonant cluster systems of both RG and MG, we now turn to a discussion of a predicted trajectory or developmental path for consonant cluster acquisition in CA.

5. Developmental path

In the previous sections, we have described the pattern of word-final consonant clusters of two siblings at the same age (2;8) acquiring Cairene Arabic in a monolingual setting. While the children were at the same age when the data were collected, RG seemed to be further ahead in her cluster acquisition than MG. By comparing the productions of the two children, we can hypothesize a developmental path for CA cluster acquisition. Recall from Section 2 that CA allows for words to end in any two consonant phonemes regardless of their sonority relation. This is different from languages like English as well as other dialects of Arabic such as Lebanese (Haddad, 1984), which, while allowing for word-final clusters, do not normally permit such clusters with rising sonority. Given the general rarity of rising sonority final clusters in the world's languages and the more frequent occurrence of falling sonority clusters, one might hypothesize that a developmental path for final cluster acquisition in CA would entail that falling sonority clusters (and level sonority clusters) are acquired before rising sonority clusters. Although this hypothesis is generally true for both children in this study, since neither child had accurately acquired rising sonority clusters at 2 years 8 months, the comparison of the productions of these two children suggests that the developmental path of cluster acquisition is more nuanced in that certain falling sonority clusters are acquired before others. More specifically, it is of note that both children had acquired pharyngeal-initial final clusters. Since these are the only clusters that MG produced target-appropriately, it may be that these are the earliest clusters acquired. If we assume that the pharyngeals of Cairene Arabic have the phonetic properties of glides, as has been argued for by Elgendy (2001), then we would maintain that the cluster type that is acquired first is the one in which the first consonant of the cluster is of the highest sonority among consonants.

In addition to the pharyngeal-initial final clusters, RG had acquired a second type of falling sonority cluster by the age of 2 years 8 months: Nasal + Obstruent clusters. Compare for example, RG's pronunciation of /bint/ 'girl' in (9) k., where the cluster was pronounced target-appropriately, with MG's pronunciation of the same word shown in (6) c., in which there is gemination ([bitt]). The comparison of the two children suggests that RG was further along in her acquisition of final clusters and that Nasal + Obstruent clusters are acquired relatively early in the final cluster developmental path. The reason for this should be clear in that as seen in a word like [bint], there is only one place of articulation (coronal) in the cluster; thus, in an articulatory sense, these clusters are "easier" than clusters where the two consonants are not homorganic. That this is at issue can be seen in RG's pronunciation of target [ʃams] 'sun' in (9) i. as [sans], where she showed exceptional assimilation of the bilabial nasal to the coronal fricative so that the final cluster surfaced as homorganic. Importantly, sonority fall is still a factor since a rising sonority target cluster with an initial nasal consonant as in [naml] 'ants' ((9) v.) was pronounced with gemination, [namm], and so is distinct from the falling sonority Nasal + Obstruent clusters which are acquired earlier.

A third type of final consonant clusters that RG had acquired by 2 years 8 months was the Sibilant + Obstruent variety. From a certain perspective, the early acquisition of this type of obstruent-obstruent cluster is somewhat striking since in many languages, including English, Sibilant + Obstruent clusters are special because they can occur as onset clusters (or coda clusters), even though other types of obstruent-obstruent clusters are disallowed or restricted. In English, for example, the clusters [sp], [st], and [sk] are the only obstruent-obstruent clusters permitted in complex onsets. With respect to codas, [sp] and [sk] are the only obstruent-obstruent codas that end in a non-coronal consonant. While the special nature of Sibilant + Obstruent clusters for languages like English is well-known (Goad, 2011), these clusters are typically not treated as special in Arabic. Thus, it is of note that RG treated them as a distinct type in her acquisition of final clusters. Goad (2011) points out that for languages like English and Dutch, the acquisition of s-clusters is often independent of the acquisition of other cluster types with respect to sonority. We suggest that for RG the early acquisition of Sibilant + Obstruent clusters was independent of the acquisition of other clusters based on sonority, and we leave it as just an observation that RG distinguished Sibilant + Obstruent clusters from other cluster types even though these do not seem to have unique properties in Arabic phonology.

Finally, with respect to the final consonant clusters that neither MG nor RG had acquired target appropriately, we can divide them into three types: other falling sonority clusters such as liquid-obstruent and liquid-nasal clusters; level sonority clusters; and rising sonority clusters. These clusters were all realized with gemination of one of the last two consonants for both children, though the gemination pattern applied by RG differed slightly from that applied by MG. While MG typically geminated the final consonant of these clusters as long as it was not a pharyngeal (seen in (6) d.–h.), RG geminated the final consonant in a falling sonority cluster ((9) n.–s.) and the initial consonant in a rising sonority cluster ((9) v.–x.). Given that RG was distinguishing between rising and falling sonority in these cluster types, we speculate that, in the further developmental path for final cluster acquisition, other falling sonority clusters would be acquired before rising sonority clusters (abstracting away from the difficulty that both children have with the phoneme /r/). Although we leave for future research a more detailed examination of longitudinal data, it appears that, in general, falling sonority final clusters are acquired before rising ones even though both cluster types are common in CA.

6. Major findings and conclusions

As far as we are aware, this detailed presentation of final consonant cluster acquisition data of two children (aged 2;8) who are acquiring Cairene Arabic in a monolingual setting, is the first study that has a specific focus on the acquisition of such clusters. As previously mentioned, examining clusters in CA is particularly interesting because of the full range of consonant clusters allowed in word-final position in CA. Thus, we find it significant that cluster acquisition seems to be sensitive to sonority considerations, and, for RG, to the special status of Sibilant + Obstruent clusters even though neither of these is apparent in the adult phonology (which allows for any cluster type). However, what we consider to be our most important finding is the evidence that gemination is the major "repair" strategy attested in L1 acquisition of final consonant clusters for Cairene Arabic for both children at this early stage of development. This strategy has not been documented in languages like English and Dutch, where the simple deletion of a consonant or even of the final cluster can occur (e.g., Fikkert, 1994). In fact, as seen in work like that of McLeod et al. (2002), gemination is not even considered as a possible strategy in the development of final consonant cluster acquisition. McLeod et al., for example, list processes like deletion, epenthesis, and metathesis in cluster development, but not gemination. However, we suspect that gemination is a common strategy for target final clusters in Arabic dialects in general, given that all Arabic dialects seem to have final geminates and that they seem to be learned very early in the acquisition process.

There are other findings in our study, not necessarily related to consonant cluster development, that are worth mentioning. First, both children had acquired pharyngeal consonants early, a finding that is consistent with Ayyad and Bernhardt's (2009) work on Kuwaiti Arabic, though not consistent with the work on Jordanian Arabic (Amayreh, 1994, 2003; Amayreh and Dyson, 1998). An important difference regarding pharyngeals between our two subjects is that MG lacked geminate pharyngeals, but RG had them. Second, /r/ was acquired late for both children. However, the replacement strategy of target /r/ was quite different for each of these two children. MG tended to replace /r/ with [l]. RG often treated target /r/ as [d], and sometimes /r/ underwent consonant harmony. Further, RG also seemed to only have /l/ in onset position; she did not have /l/ in coda position. MG did not demonstrate difficulty with coda /l/. Third, RG had across-the-board velar fronting for /k/ and /g/, as seen by the data items in (9) j. and p., in which these target sounds were realized as [t] and [d], respectively. RG also showed occasional instances of consonant harmony of initial onsets, as in (9) i. and k. MG, on the other hand, showed no signs of velar fronting or consonant harmony. Instead, MG had extensive glottal replacement in word-initial position, which RG did not have. We suspect that these phenomena may be common in Arabic developmental phonology. For example, Saleh et al. (2007) reported glottal replacement in children acquiring Egyptian Arabic, and there is some consonant harmony in the Kuwaiti data reported by Ayyad and Bernhardt (2009). Future research is needed for the investigation of these processes in Arabic developmental phonology.

Finally, we would like to relate our findings to the ongoing debate in the literature on acquisitional phonology as to the very nature of the acquisition process (Rose and Inkelas, 2011). In the relevant literature on acquisition, two contrasting viewpoints can be found. One is the view that phonological acquisition is just articulatory development (Hale & Reiss, 2008; Blevins, 2009). Blevins (2009, p. 328) maintains that, "A wealth of data illustrate that the majority of recurrent features of child phonology (e.g., CV syllable stage, cluster reduction stage, consonant harmony) are reflections of articulatory developmental stages, indicating developmental constraints on performance, not on language competence." This can be interpreted as implying that children across different languages should manifest very similar strategies in phonological acquisition, since all children have essentially the same articulatory apparatus. The other view is that the nature of developmental errors is dependent on the structure of the language being learned. That is, errors in development reveal the linguistic competence that the child has with respect to the language (Fikkert, 1994; Demuth, 1996). This implies that children learning different languages will manifest different strategies in acquisition, reflecting the structures of the languages being acquired. Our claim is that the Cairene Arabic L1 cluster acquisition data presented in this paper support the

second position. The structure of the phonological grammar plays an important role in the nature of the child's performance. This is most clearly seen by the predominance of gemination for the target final cluster. As noted earlier, gemination as a strategy in L1 acquisition for the pronunciation of final clusters has not been witnessed in other languages such as English, where children often delete consonants or insert vowels in final clusters. The strategy of word-final consonant gemination seen with both MG and RG can be understood as a means of preserving the prosodic moraic structure of the bimoraic final syllable in words that end in two consonants without the need for making two distinct consonantal gestures. This is seen by the parallel moraic structure in (7) for target /bint/ 'girl' and MG's pronunciation [bitt] with a geminate. Moreover, our acquisition data is consistent with the observation of Khattab and Al-Tamimi (2011), that children acquiring Lebanese Arabic do not seem to go through a CV (or CVC) stage. Such word forms would be monomoraic in Arabic, and many Arabic dialects (including Cairene) require content words to be minimally bimoraic (e.g., CVCC). Neither MG nor RG seem to have gone through a CV stage nor do they really have a process of consonant cluster reduction. This is surprising, given a view like that espoused by Hale and Reiss (2008) and Blevins (2009) who contend that acquisition is largely reducible to articulatory development. We thus conclude that the Cairene Arabic acquisition patterns evident in data from RG and MG provide insights into their linguistic competence, showing tacit knowledge of the moraic structure of the language. We would contend that knowledge of the nature of the grammar, that is, linguistic competence, plays an important role in determining the specific manifestation of the performance. The nature of the child's performance seems to be controlled by the higher-level linguistic structure. It is not reducible to just articulatory development.[4] Finally, although our two case studies are not longitudinal, we hope that

4. A couple of reservations about our analysis have been raised by two anonymous reviewers that we address in this footnote. One reviewer has concerns that the two children, MG and RG, are siblings. The implication is that since the children are receiving similar input, it would not be surprising that they both have gemination. This, then, would make it harder to generalize our finding to a larger child Arabic population. To respond to this, we would like to make two points: First, as detailed in the second paragraph of Section 2, MG and RG had quite different phonologies. For example, RG had across-the-board velar fronting of target /k/ and /g/ and instances of consonant harmony, while MG did not show any velar fronting and has widespread glottal replacement of onset consonants. Further, while neither child had target appropriate /r/, MG consistently replaced /r/ with [l] while RG frequently replaced it with [d]. Given that these two children are quite different in their phonological development, we find it even more telling that they both used gemination for target consonant clusters. Second, CA baby talk words often display final geminates. By 'baby talk,' we mean the way that adults imitate the speech of young children. Such words include [kuxx] 'something bad', [mamm] 'food', and [dahh] 'something good'. This implies that adults perceive that it is common for children to make final geminates.

these preliminary findings will encourage such studies with larger samples in a range of Arabic dialects.

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The same reviewer wonders if the children were hearing a lot of deleted consonants in the input final clusters given that it is well known from English that word-final /t/ and /d/ are often deleted (especially after another consonant) by speakers of all ages. Relatedly, the other reviewer wonders about the functional load of consonants. We are quite certain that children are not hearing deleted consonants as part of the lexical input. For example, it is unlikely that adults are pronouncing a word like /kalb/ 'dog' as [kab] or [kal] or even as [kabb] or [kall] when speaking to children. Keep in mind that final CVCC syllables always carry stress whereas final CVC syllables do not. Consequently, a consonant cannot just be deleted at the end of a word as in English, since it would play havoc with the stress pattern. Moreover, in monosyllabic CVCC words, a consonant cannot just be deleted since there are no real content words in CA that are CVC. Recall from Section 2 that Khattab and Al-Tamimi (2011) found that the Lebanese Arabic children of their study did not witness a CV or CVC stage. This is consistent with our findings and makes sense because CV and CVC content words in CA (and Lebanese Arabic) are rare or non-existent. Further, given the root and pattern system of Arabic morphology, deleting a consonant would play havoc with the lexical meaning of a root, which is expressed by the consonants. In this sense, we suspect that Arabic consonants carry a high functional load. Consequently, our strong impression is that adult Arabic speakers do not delete a final consonant of a content word in a way that English speakers delete a final /t/ or /d/. As is well known, dialects like CA often use the strategy of epenthesis over a word boundary so that a word-final consonant would not be deleted as exemplified by the typical CA pronunciation of *bint kibiira* as [bin.tik.bii.ra] 'a big girl'. Compare this with English "grant competition" where the final /t/ is likely to delete and there is no regular process of epenthesis to prevent its deletion.

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