PHONOLOGICAL DEVELOPMENT OF TYPICALLY DEVELOPING KUWAITI ARABIC–SPEAKING PRESCHOOLERS

by

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Abstract

This study documents the development of the phonological skills of typically developing Kuwaiti Arabic-speaking preschool-age children and lays the foundation for a speech-assessment tool for Kuwaiti Arabic. Kuwaiti Arabic is the spoken dialect in Kuwait. The segmental inventory of Kuwaiti Arabic is similar to that of other spoken Arabic dialects and that of Modern Standard Arabic, although with some variation across dialects.

The current study used a standard single-word picture- and object-based elicitation that evaluates consonants and vowels across word positions, within a variety of word lengths and structures (88 words altogether). Speech samples were collected by the author from 80 monolingual 4- to 5-year-old Kuwaiti children and were recorded on an M-Audio Micro Track II 24/96 recorder (Beier TGX 58 microphone). This age group was selected because previous research has shown that the Arabic phonological repertoire may be almost complete by age 4; thus, these children had reached an age where it would be essential to intervene if they showed speech delays. Children were recruited from preschools across the state of Kuwait in order to include all dialects and districts. The author, who is a native speaker of Kuwaiti Arabic, was the primary transcriber, with reliability checks conducted on 10% of the sample by phonetically trained transcribers. A nonlinear phonological framework based on Bernhardt and Stemberger (1998) was adopted for analysis of word structures, consonants and features.

Preliminary data show that Kuwaiti preschoolers have a rich consonantal inventory across the places of articulation, including emphatic and non-emphatic stops, nasals, approximants, and uvular and pharyngeal fricatives. Some features appear to be still undergoing development. Several word lengths have been acquired by this age, from

monosyllabic to four-syllable words. Morphophonemic alternations appear to be still developing.

The data for relatively comparable groups of younger and older 4-year-olds were analyzed and showed developmental change across time. In addition, a group at-risk for protracted phonological development was identified which had notably less proficiency in phonological production than the other two groups. Finally, this study attempts to set some of the groundwork for the future development of a phonological test for Kuwaiti Arabic.

Preface

This study was conducted by the author, who prepared the design, collected the data in Kuwait and analysed the data. The supervisory committee provided feedback and suggestions on the design and analysis. No manuscripts have yet been prepared. The Behavioral Research Ethics Board at the University of British Columbia approved the project: Certificate number H08-02302.

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List of Abbreviations

WI	Word-initial	[hi]	High
WM	Word-medial	[lo]	Low
WF	Word-final	[bk]	Back
C	Consonant	Pharyn	Pharyngeal
V	Vowel	Glott	Glottal
S	Strong (stressed)	Meta(th)	Metathesis
w	Weak (unstressed)	Coal	Coalescence
[cons]	Consonantal	Assim	Assimilation
[cont]	Continuant	Redup	Reduplication
[lat]	Lateral	IWSD	(Initial) Weak Syllable
[nas]	Nasal		Deletion
[vd]	Voiced	Pl	Plural
[vl]	Voiceless	Sg	Singular
[sg]	Spread glottis	B	Bedouin
[cg]	Constricted glottis	SD	Standard Deviation
Lab	Labial	WWM	Whole Word Match
Cor	Coronal	Del	Deletion
[ant]	Anterior		
[grvd]	grooved		
Dors	Dorsal		

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To Waleed, my husband,

my amazing children Naser and Khaled,

and our little angel Ali.

To the souls of my parents.

1 INTRODUCTION

This thesis studies the phonological development of Kuwaiti Arabic, the dialect of Arabic spoken in the State of Kuwait. It is directed toward establishing reference norms by collecting and presenting data on the development of speech sounds among monolingual preschoolers. This introduction provides the necessary background for the study. The first section outlines the major aspects of (nonlinear) phonological theory that are assumed by the study, and then gives an overview of Arabic phonology. The second section describes children's phonological development in English (because most previous studies have been on English) and looks at studies for some dialects of Arabic (primarily Jordanian and Egyptian Arabic). This is followed by a discussion of methodology for evaluating children's phonological development, and finally by the research questions that the dissertation will investigate.

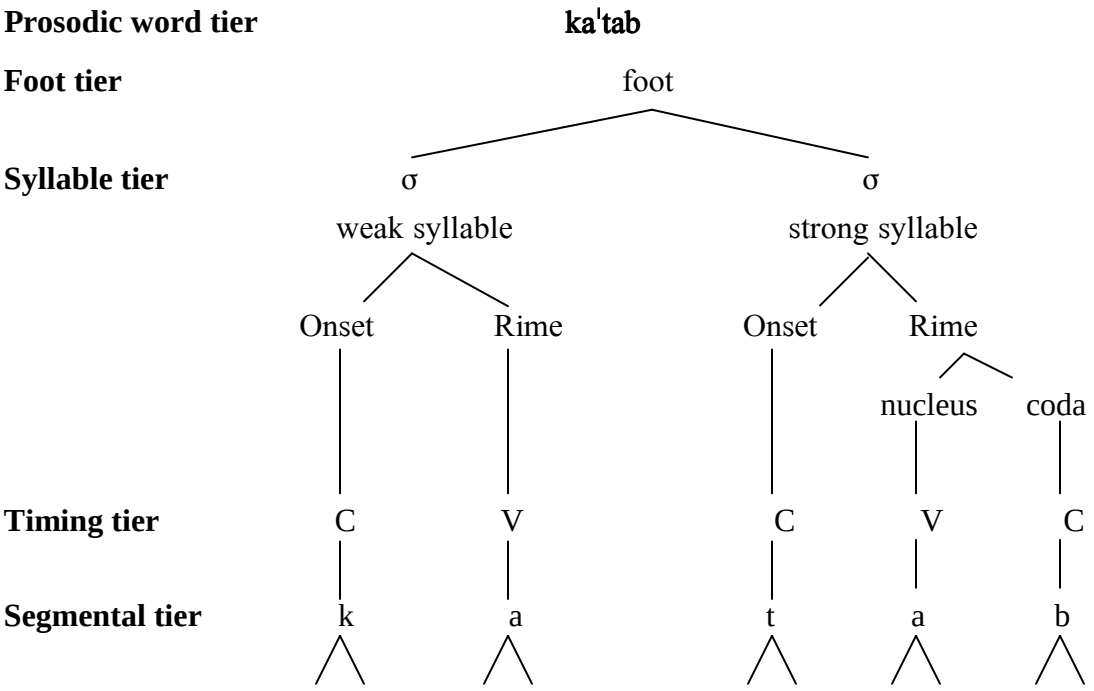
1.1 Theoretical Background: Phonology

The term "phonology" denotes the sound systems of a language, including both articulatory-phonetic and cognitive-linguistic components (Gordon-Brannan and Weiss, 2007). This is sometimes extended to include all aspects of speech sounds, including speech perception and production, as well as cognitive and motor aspects of speech (Stoel-Gammon and Dunn, 1985).

For this study, a nonlinear phonological framework provides the basis for analysis. This framework was chosen because it provides a comprehensive analysis of phonological form at many levels of representation, from the phrase to the feature. Previous phonological process analyses often fail to capture the feature level of representation or different levels of word

structure (Bernhardt and Stemberger, 1998). This section presents an overview of the nonlinear phonological framework for this study (as in Bernhardt and Stemberger, 1998, and Kenstowicz, 1994). Nonlinear phonology describes the phonological form of words in terms of a hierarchy of phonological elements as well as a linear sequence (characteristic of other older rule-based theories)**.** Figure 1 displays this hierarchy, where features (the smallest units) combine together to build up segments (consonants, vowels), syllables, feet, and prosodic word.

Figure 1.1 The phonological hierarchy



The following sections will outline the important characteristics of each level of the phonological hierarchy.

1.1.1 Phonological Features

Phonological features are the smallest units that speech sounds are composed of; they encode the phonetic information of segments of speech (either acoustic or articulatory).

Roman Jakobson, a pioneer in the discipline, posited a theory of distinctive features (e.g., Jakobson and Halle, 1956), in which the phoneme consists of a bundle of binary and privative features. Jakobson, Fant and Halle (1952) refer to features in terms of acoustic properties, i.e., properties based on the physical characteristics of the sound wave produced by speech (Ladefoged, 2005, p.8).

Chomsky and Halle introduced a new feature system (in *The Sound Pattern of English* [SPE], 1968) based primarily on articulatory rather than acoustic features. "Articulatory", in this case, implies a system that categorizes sounds based primarily on the movement of the articulators. Chomsky and Halle's system was designed to be applied to all languages, and demonstrated that the articulatory properties of human speech can be represented in a way that accounts for phonological alternations and patterns across languages (Yavaş, 1998). This approach has since been further developed by many researchers.

For the current study, the feature framework primarily follows Bernhardt and Stemberger (1998) in order to be able to compare Arabic with a variety of languages in an ongoing crosslinguistic study (Bernhardt and Stemberger, 2010). The Bernhardt and Stemberger feature set is fairly standard and based on Chomsky and Halle (1968), Sagey (1986), and McCarthy (1988). The features unique to Bernhardt and Stemberger (1998) are [+labiodental] for /f/ and /v/ and [grooved] (referring to tongue shape for coronal fricatives).

The over-arching feature categories are Manner, Place, and Laryngeal. *Manner* features define *how* the active and passive articulatory organs approximate or make contact in order to produce speech sounds. Manner features thus address how airflow is impeded and redirected, as well as whether turbulence (frication, bursts) is created. *Place* features describe *where* the

articulatory organs approximate or make contact. *Laryngeal* features describe the state of the glottis in the production of a speech sound (see Figure 1.2 and Table 1.2 later in the section).

Bernhardt and Stemberger (1998, Chapter 3) refer to subsidiary issues related to features, such as the description of affricates and the notion of binary versus privative features. Clements and Keyser (1983) suggest that affricates could be an amalgamation of two segments, or a single segment with binary values of the feature [+continuant] - [-continuant]. On the other hand, Shaw (1991), LaCharité (1993), and Rubach (1994) describe affricates as [+strident] ([+grooved]) stops. Bernhardt and Stemberger propose that some affricates may be [+grooved] stops, and others may be [-continuant] at the beginning and [+continuant] at the end.

The term "privative feature" was adopted for single-valued features. If a privative feature is not indicated, it is simply absent because of lack of relevance (Bernhardt and Stemberger, 1998); e.g., [Labial] is not relevant to the description of the coronal /t/. Bernhardt and Stemberger (1998) agree with the idea that major places of articulation are privative, e.g., (Sagey, 1986) but they take a relatively conservative position, calling only major places of articulation privative and the rest binary. Binary features must be explicitly present or not present for a particular segment; i.e., the feature [anterior] is a specific type of [Coronal] (only) and therefore the segment must be designated as either having [+] (as in /t/) or [-] (as in /ʃ/) [anterior] values.

Default and Nondefault Features

Features can also be described in terms of their status in a phonological system. In previous accounts (those of Jakobson and of Chomsky and Halle, as cited above), features

were designated as marked (less frequent, more 'complex') or unmarked (more frequent, less complex). An example of an unmarked feature would be [Coronal, +anterior], e.g., /t/, /d/, /n/, and a marked feature would be [Dorsal], e.g., /k/, /g/, /ŋ/. Markedness can be thought of in terms of the "naturalness" with which a sound is produced and acquired (Edwards and Shriberg, 1983). Toombs, Singh, and Hayden (1981) describe unmarked features in child substitutions as those that:

1. require less articulatory effort
2. are less acoustically complex
3. are less perceptually ambiguous
4. are acquired earlier
5. occur more often in the languages of world.

While marked and unmarked features may vary somewhat from language to language, in general the following observation can be made:

1. Voiceless obstruents are less marked than voiced obstruents.
2. Stops are less marked than fricatives.
3. Fricatives are less marked than affricates.
4. [n] is the least marked nasal.
5. [s] is the least marked fricative.
6. CV syllables are the least marked, followed by CVC.

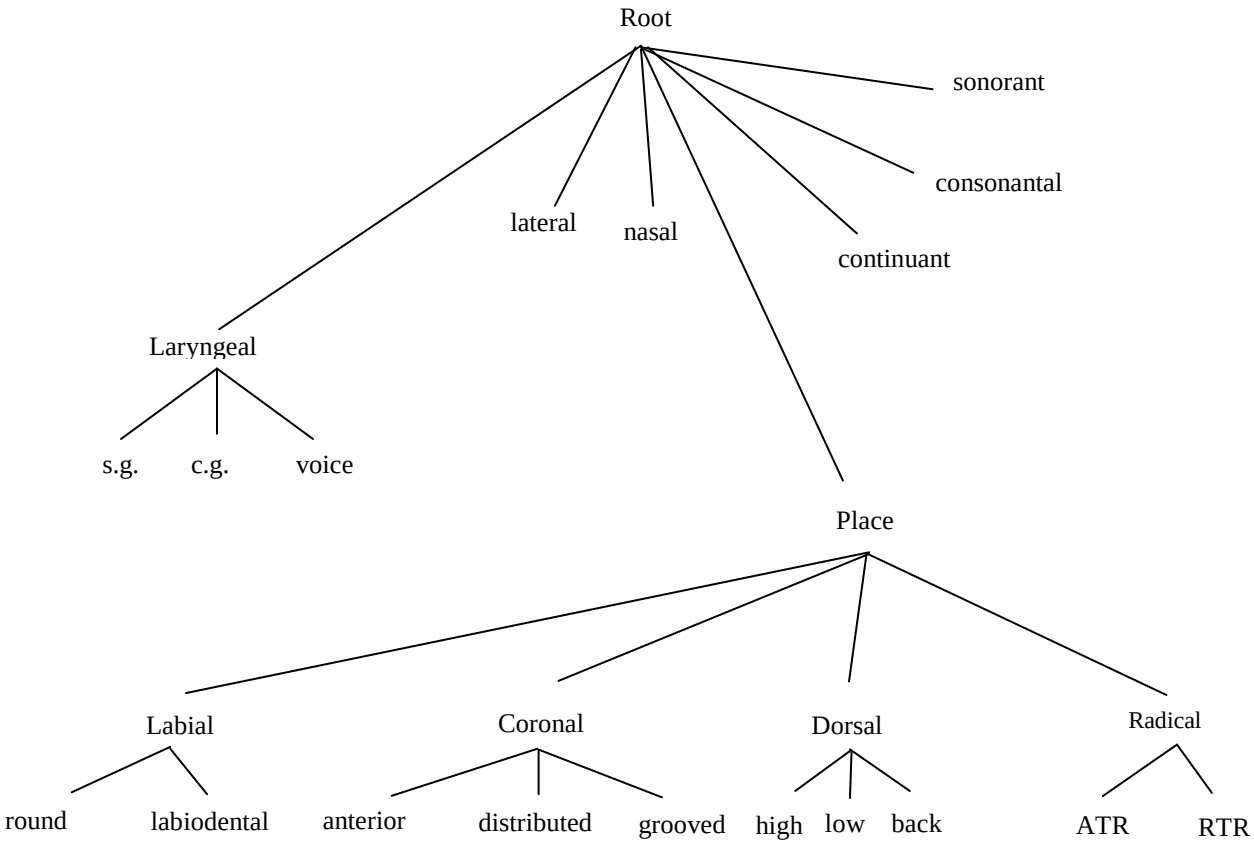
Sloat, Taylor and Hoard (1978) note that when the presence of one phoneme in a language implies the presence of another phoneme (e.g., /d/ implies /t/, in the sense that a language with /d/ is more likely to also have /t/ than a language with /t/ is likely to have /d/), the

phoneme whose presence is implied is likely to be unmarked. They refer to this as an "implicational law".

Default features are those in a given phonological system that are possible, unmarked, and frequent. Nondefault (more marked) features are those that must be learned and represented underlylingly. Bernhardt and Stemberger (1998) note that default features (often frequent) often appear as substitutions in child phonology; e.g., [t] for /k/ or [d] for /g/. In the case of assimilation patterns the opposite often happens, where more marked, nondefault features replace the default features; e.g., [gag] for *dog*. However, Bernhardt and Stemberger propose that defaults may vary across children.

In their interpretation of the relationship between features (see Figure 1.2 below), Bernhardt and Stemberger (1998) join most other researchers (e.g., Goldsmith, 1976) who are theoretically aligned with a nonlinear phonology framework, in which there is not a single line of segments but rather a group of lines (Bernhardt and Stemberger, 1998, p. 75). This relates to the concept of "tiers," with each feature assigned to one "tier" or "level," e.g., the coronal tier, the continuant tier, the voicing tier, or the sonorant tier. Note that s.g. means "spread glottis" and c.g. means "constricted glottis" below.

Figure 1.2 Feature geometry (from Bernhardt and Stemberger, 1998, with permission) for English



Individual segments reflect combinations of the feature tiers; e.g., the speech sound /v/ incorporates the features [+consonantal], [+continuant], [-sonorant], [Labial], [+labiodental], [+voiced].

The following section addresses phonological representation above the segmental and featural levels.

1.2 Prosodic Structure

This section describes basic levels of prosodic structure, from timing units to syllables, to feet and prosodic words.

1.2.1 Timing Units

Timing units differentiate elements by their rhythmic status in the syllable and word. Bernhardt and Stemberger (1998) identify the characteristics of timing units in the following three ways:

1. They are “enablers” (p. 105),
2. They convey real-time duration for associated speech sound production;
3. They are independent phonological elements.

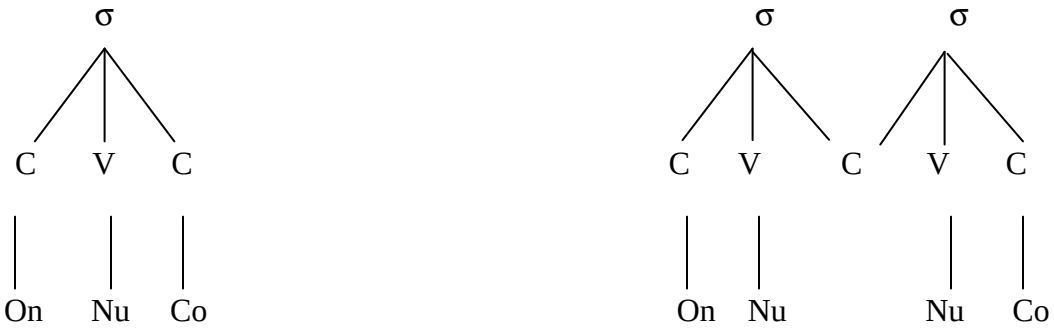
A specific theory concerning timing units is Moraic Theory (Hayes, 1989), where a mora is represented by the Greek symbol μ. In terms of the properties of syllable weight, the mora, Kenstowicz (1994) explains, is not a “species of sound” but a prosodic unit: a structure or a constituent of the syllable “intervening between the [σ] and the phonemic string” (p. 293). This approach assigns moras to all vowels, inclusive of long vowels and diphthongs. Some syllable-final (coda) consonants also have moras in some languages. A light syllable comprises a single mora, and a heavy syllable two, the heavier syllable being referred to as *bimoraic*. Onsets have no moras, and two moras per syllable are often considered the maximum (but see e.g., Hayes, 1989; Hammond, 1999).

1.2.2 Syllables

The next level above the timing unit (see Figure 1.3 below) is the syllable, which functions as a grouping of the segments and their features and the timing units. Bernhardt and Stemberger (1998) note that the syllable is the smallest major grouping of segments that all phonologists agree on, although the status of syllable structure as underlying or not was a point of controversy among early generative phonologists such as Chomsky and Halle (1968), who did not assign representations to syllables.

A syllable must have a peak or head (nucleus Nu), which is usually a vowel. The peak is often preceded by an onset (On) and followed by a coda (Co). The peak of the syllable plus the coda consonants following it are often referred to as the rime (or rhyme). For a single-syllable word, all segments before the head are in the onset (see Figure 1.3 below). There is conflicting evidence regarding intervocalic consonants; they could either be the coda of the first syllable, the onset of the second one (Figure 1.3), or ambisyllabic. Note that the timing tier is represented here with consonant (C) and vowel (V) in keeping with the rest of the thesis.

Figure 1.3 Syllable representation



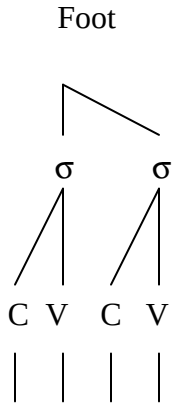
1.2.3 Feet

The next-highest level of the hierarchy is the foot. The foot is a major unit of measurement to do with stress assignment (as are timing units). One approach among a number mentioned by Goldsmith (1990) asserts that stress should be regarded as uniquely different from all other aspects of phonology. However, Bernhardt and Stemberger (1998) regard the foot simply as a node where two syllables or more may group together (following McCarthy and Prince (1993).

The foot must contain a stressed syllable, which is its head. If the first syllable is stressed then the foot is left-prominent, or trochaic, as in the English word *poppy* ([ˈpɑːˌpi]). Conversely, if the second syllable is stressed the foot is right-prominent, or iambic, as in the English word *salon* ([səˌˈlɑːn]).

Phonologists use the concept of 'foot' for measuring the size of words and their stress patterns (relating to the number of moras per syllable). According to the universal claims of e.g., Mester (1994), a stressed syllable must contain at least two moras. Other arguments posit the syllable as the major constituent of feet rather than moras. (See Figure 1.4.)

Figure 1.4 Foot structure



1.2.4 Prosodic Words

The highest level of the word hierarchy is the prosodic word level, which groups the feet of the word (and all of the other levels). Languages vary in their allowed word lengths; words can be as short as one syllable (a “degenerate foot”) or extremely long, with multiple compounding and many feet.

The previous sections have outlined the structure of phonological form. The following section will look at phonological patterns from the perspective of nonlinear phonology. It will introduce the constraint-based Optimality Theory approach and its application to phonological patterns.

1.3 Patterns in Nonlinear Phonology

Bernhardt and Stemberger (1998) and others (e.g., McCarthy, 2004; Barlow and Gierut, 1999) describe phonological patterns in nonlinear phonology using both rules/processes and constraints, their preference being a constraint-based approach (Optimality Theory). The major difference between the rule/process view and the constraints view is that a rule has to be actively applied to describe the differences in pronunciation, for example “stopping” of fricatives, /ʃ/> [t]. Since young children have reduced ability to articulate, it is impossible for them to produce completely adult-like utterances (constraints on pronunciation); the repair strategy or rule/process applies where the adult pronunciation is impossible. Multilinear phonology has two possible types of rules or processes: addition and deletion (of features, nodes, timing units or association lines). An example of this would be delinking (deletion) of [+continuant] when/f/ > [p], and the insertion of default [-continuant].

In contrast to that approach, the constraint-only approach deals with the interaction of faithfulness and markedness. Faithfulness is a family of constraints requiring the surface pronunciation to resemble the underlying representation of the segment. In a constraint-based theory, deletion and insertion of segments are not due to a rule but arise from violations of the faithfulness constraints (and high-ranked markedness constraints). That is, fricatives are not 'stopped', but if the child cannot be faithful to the fricative feature [+continuant], yet must replace the fricatives with something, the default feature [-continuant] appears in its place; there is no active rule/process converting [+continuant] into [-continuant].

The constraints-only theory looks at speech from both the relational and independent perspectives, unlike the natural phonology approach, which focuses on relational analyses of the child's speech. The system evaluates outputs against all constraints at once. The output violating the least number of high-ranked markedness constraints and/or supporting required faithfulness to the input will be evaluated as 'optimal' and therefore produced (Gordon-Brannan and Weiss, 2007).

1.4 Arabic Phonology

Arabic is a Semitic language spoken by more than 150 million people and falling within the Afro-Asiatic language family (Amayreh and Dyson, 1998). It contains (with variations across dialects):

- 27 consonant phonemes produced across the whole vocal tract from lips to glottis (Ammar and Morsi, 2006)
- Three short and three long vowels /i/, /u/, /a/, /iː/, /uː/, /aː/
- Two semivowels /w/, /j/ (Omar, 1991)

Arabic phonology canonically consists of 35 phonemes. The inventory overlaps with that of English, although Arabic has fewer vowels and some consonant differences. For example, Arabic has no /p/ or /v/ but has a trilled /r/, and a set of uvular, pharyngeal and pharyngealized segments. Gutturals in Arabic (sometimes called emphatics) are those produced in the pharyngeal and uvular regions or that have secondary pharyngealized articulation (McCarthy, 1989). Kenstowicz (1994) describes secondary articulation as amplification of segments by the addition of qualities such as rounding, tongue body palatalization or velarization; for Arabic, pharyngealization of oral phones results from the retraction of the tongue root toward the back wall of the pharynx (discussed further below).

As have many other authors, Amayreh and Dyson (1998) mention the issue of *diglossia*, which refers to the duality inherent to spoken and written Arabic. Colloquial spoken Arabic differs notably from the language used in broadcast media and also from the written language. Major differences may occur on the level of single speech sounds or of whole words, where speech sounds may be replaced by other phonetically close ones when the words are used in colloquial Arabic. For example, in Kuwaiti Arabic, the emphatic /q/ is usually replaced by /g/, the emphatic /gˁ/, or /ʤ/ (in the Gulf countries only). This also applies to the Arabic spoken in Gulf countries, in Jordan, and in parts of Egypt and Syria. The word /qeddæm/ (‘forward’) is pronounced [ʤeddæm] in Kuwaiti Arabic. In Cairene Arabic and in the modern city dialects of Jordan, Palestine and Syria, the pharyngeal emphatic stop /q/ is replaced by the glottal stop /ʔ/. Egyptian Arabic, especially the dialect spoken in Cairo, replaces the sound /ʤ/ with /g/ (Amayreh and Dyson, 2000), and /ð/ and /θ/

are replaced with /z/ and /s/ respectively. In Egypt the emphatic /ðˤ/ is replaced by the emphatic /zˤ/.

Dialects also differ in terms of lexical items. For example, *sock* is expressed as /dlæʁ/ in Kuwaiti Arabic, in Saudi Arabia and Egypt as /ʃʌrab/, and in Jordan, Syria and Palestine as /dʒraːb/.

1.4.1 Phonology and Phonetics Research on Arabic

Compared with studies of phonology and phonetics in languages such as English, Arabic lags behind. While stressing the need for more research in phonology and phonetics in his translation of Bertil Malmberg's (1963) book, *Phonetics*, Hleil (1994) indicates the reasons for the lack of research. One challenge Hleil encountered in his translation of Malmberg's work was the limited range of Arabic phonological terminology. Prior to beginning the translation, he found it necessary to establish a corpus or database for the terminology to be translated, by doing an extensive study to verify the translated definitions. Hleil justifies the translation of Malmberg's *Phonetics* (1994) into Arabic by referring to its reliability and the inclusion of many examples of phonological concepts from English, French, Spanish, Danish, and other languages.

Arabic phonology is discussed below in terms of the nonlinear phonological hierarchy, starting with features.

1.4.2 Segments and Features of Kuwaiti Arabic

For Kuwaiti Arabic, Table 1.1 shows the relationship between features (based on Bernhardt and Stemberger, 1998) and the various consonants.

Table 1.1 Kuwaiti Arabic consonants and features

Features	**Consonants**
Manner Features	
[+ consonantal]	m n ŋ (not word-initially) b t tˤ d dˤ k (kˤ) g (gˤ) q qˤ f s sˤ z θ ð ðˤ ʃ tʃ dʒ χ ʁ ħ ʕ r l
[-consonantal]	j* w* h ʔ
[+lateral]	l
[+nasal]	m n ŋ (ŋ not word-initially)
[-continuant] [-nasal]	b t tˤ d dˤ k (kˤ) g (gˤ) q qˤ
[+continuant](and [-sonorant])	f s sˤ z θ ð ðˤ ʃ χ ʁ ħ ʕ
[-continuant]/[+continuant]	tʃ dʒ
Laryngeal Features	
[+voiced] obstruents	b d dˤ g (gˤ) z ð ðˤ dʒ ʁ ʕ
[-voiced]	t tˤ k kˤ q qˤ f s sˤ θ ʃ tʃ χ ħ ʔ h
[+spread glottis]	f s sˤ θ ʃ tʃ χ ħ h
Place Features	
Labial	m b f w
Coronal [+anterior]	n t tˤ d dˤ θ ð ðˤ s sˤ z l r
Coronal [-anterior]	ʃ tʃ dʒ j
Coronal [+grooved]	s sˤ z ʃ tʃ dʒ
Coronal [-grooved]	θ ð ðˤ (+all coronal stops and sonorants)
Dorsal	k kˤ g gˤ w j (ŋ not word- initially) χ ʁ
Pharyngeal	χ ʁ (gutturals as in McCarthy, 1989) ħ ʕ ʔ h

Note. /j/ and /w/ are considered glides in word-final position.

The table above lists the Arabic inventory according to the feature system of Bernhardt and Stemberger (1998) augmented with McCarthy's (1989) approach to "gutturals" (uvulars, pharyngeals, glottals, as discussed below). Arabic has the following categories of features by manner:

1. [+consonantal]: all consonants except [-consonantal] /w/, /j/, /h/ and /ʔ/

2. [+nasal]: /m/, /n/,/ ŋ/

3. [-continuant] (stops): /b/, /t/, /d/, /k/, and /g/ and pharyngealized 'emphatic' stops /tˤ/, /dˤ/, /kˤ/, /gˤ/ and /q/

4. The same fricatives and affricates as English (except for /v/ and /ʒ/) plus emphatic fricatives such as /ðˤ/ and /sˤ/, uvular fricatives /χ/ and /ʁ/, and pharyngeal fricatives /ħ/ and /ʕ/.

5. The [+voiced] obstruents are similar to those of English (although there is no /v/ or /ʒ/) with the addition of the uvular, pharyngeal and pharyngealized consonants noted above.

6. Voiceless obstruents include those of English without /p/, but with the addition of /χ/ and /ħ/ plus pharyngealized /tˤ/ and / sˤ/. Voiceless fricatives and affricates /f/, /θ/, /s/, /ʃ/, /tʃ/ /χ/, /ħ/ and /h/ are [+spread glottis].

Arabic place features also resemble English ones with some additions. They include:

1. [Labial]: /b/, /m/, /f/, and /w/

2. [Coronal]: both [+anterior] and [-anterior], [+grooved] and [-grooved]; i.e., /t/, /d/, /n/, /l/, /r/, grooved /s/, /z/, /ʃ/, /tʃ/, /dʒ/ and /sˤ/, ungrooved /θ/, /ð/ and /ðˤ/

3. [Dorsal]: /k/, /g/, /ŋ/, /w/ and /j/ and uvulars /q/, /χ/ and /ʁ/.

4. [Pharyngeal]: /χ/, /ʁ/ (as part of gutturals as in McCarthy, 1989), /ħ/, /ʕ/, /ʔ/ and /h/.

Note that Arabic has a set of phonemes sometimes called gutturals (McCarthy, 1989): /χ/, /ʁ/, /ħ/, /ʕ/, /h/, and /ʔ/, plus other pharyngealized segments. Pharyngeal/guttural and pharyngealized speech sounds are a hallmark of Arabic and occur with high frequency in Kuwaiti Arabic. McCarthy (1989) referred to /χ/, /ʁ/, /ħ/, /ʕ/, /h/, and /ʔ/ as a "natural class." He claimed that the guttural consonants are produced with a constriction of what he calls "the entire region" (1989, p. 2) and relates his definition to Perkell's (1980) proposal that pharyngeals are orosensory targets, where place of articulation reflects tactile/proprioceptive objectives of the tongue within the oral passage (i.e., where places of articulation are sensed regionally by the tongue within the oral passage). This perspective is distinguished from feature definition based solely on articulatory position. McCarthy states that gutturals have in common a posterior place of articulation, a high F1, and similar stricture, without sharing active articulators. These phonetic details about gutturals led him to posit a feature [Pharyngeal]; he further suggests that this feature is incompatible with the assumption of articulator-based feature theory, as in e.g., Halle (1983). The reason for this, he explains, is that three places of articulation ("active articulators") are involved, but in the same region, with similar F1 and stricture (except for the glottal stop). (He does note, however, that the only acoustic property gutturals share is the high F1.)

It is important to replicate previous studies to promote further investigation of these speech sounds in order to be able to specify the places of articulation for Kuwaiti Arabic. There are several questions remaining from McCarthy's work, namely, the nature of the studies described, the technology and the tools used in the studies, and recommendations for

future experiments. His perspective seems to keep these speech sounds in the same loop. On the other hand, no actual acoustic data are provided on these six sounds in his paper.

Future research would need to consider the findings of Esling (e.g., 2002). Esling observed articulatory production of cardinal phonetic categories using a fibre-optic nasendoscope. He reports that during the production of pharyngeals, the arytenoid cartilages move forward and up under the epiglottis. He finds the place of articulation for /ħ/ and /ʕ/ to be at the aryepiglottic folds, and refers to this as the pharyngeal articulator. Esling finds that during the production of pharyngeal sounds, the tongue root is retracted, and the larynx is raised for laryngeal sphincture and closure of the airway. He describes the feature equation [-Advanced Tongue Root] as 'raised larynx', while noting that /ħ/ and /ʕ/ may lower the larynx. Thus, there may be specific articulators relating to gutturals, rather than a general region. Much more research is needed of both an articulatory and an acoustic nature.

Moving up the hierarchy, the next section outlines Arabic syllable structure.

1.4.3 Syllable Shapes

Arabic has only three syllable shapes:

- CV, as found in the word *no* in Kuwaiti Arabic, /læ/;
- CVC, as found in the word *true* /sˁɛdʒ/ in Kuwaiti Arabic;
- CVCC, of which a good example, /bærd/, is found in the word *cold* in Kuwaiti Arabic.

According to Omar (1991) there are two additional syllable shapes if we take into consideration long vowels, such as:

- CVV, as found in the word *mine* in Kuwaiti Arabic, /lei/;
- CVVC, as found in the word *why* in Kuwaiti Arabic /leiʃ/;

Whether there is a CVVCC syllable is debatable. Omar (1991) is probably referring here to the morphological roots of Arabic and not to all words in Arabic. Anis (1952) acknowledges the five shapes noted above.

1.4.4 Stress Patterns

Old Arabic grammars did not document stress, but modern Arabic linguists have tried to standardize how stress is represented; however, stress is predictable and regular, rather than lexically contrastive as unpredictable (as in English). Some rules governing stress in Arabic are as follows:

- Primary stress should be on the final syllable of a word if it is either a CVVC or CVCC shape (super heavy syllable), e.g.:
- /nastəʕeen/ *seek for help* → CVC/CV/CVVC/

  /jəstəqirr/ *to settle* →CVC/CV/CVCC
- Primary stress may apply on the penultimate syllable if it is CVC or CVV, e.g.:

  /ʔəstəfham/ *to inquire* → CVC/CVC/CVC

  /junaːdiː/ *calling* → CV/CVV/CVV/
- Primary stress may apply on the third syllable from the last (antepenultimate) if it is of medium length and the penultimate syllable is short, for example:

  /ʕəlləmɛk/ *teach you* → CVC/CV/CVC/

/ʕəlləmou/ *teach him* → CVC/CV/CVV/

For Kuwaiti Arabic, no specific studies of stress have been reported. There may be secondary stress in some long words but this requires further investigation. In this thesis, secondary stress is occasionally noted in trisyllabic and four-syllable words (see Table 2.5). Words in Kuwaiti Arabic can be up to three or four syllables long. The feet may be two to three syllables long.

1.5 Overview of Major Patterns in Phonological Development Focusing on English and Arabic

1.5.1 Monolingual English Phonological Development

The first part of this section will review common patterns of English phonological acquisition as a basis for comparison with Arabic acquisition, reviewing the prelinguistic phase, early words and the phonemic development phase including final stabilization of the system.

Stoel-Gammon and Dunn (1985) explain normal phonological development both in terms of "the product" of acquisition or what is directly observed, and then as the processes of acquisition, which are not directly observed. More attention has been given in research to speech production rather than perception, and to segment acquisition rather than to the prosodic level. For example, Stoel-Gammon and Dunn review the ages of consonant cluster acquisition and their developmental processes, stating that it is difficult to identify developmental stages for consonant clusters, one prosodic unit. In general, Edwards and Shriberg (1983), Stoel-Gammon and Dunn (1985), and Gordon-Brannan and Weiss (2007) show consensus on phases of phonological development with respect to the broader scope of

phonological acquisition, summarized below. In each of the following sub-sections, information is included on both word structure development and segmental and feature development in keeping with nonlinear phonological theories:

1. Prelinguistic phase (0;0 - 1;0): This stage is characterized by speech-like and nonspeech-like vocalization; it is called prelinguistic because children do not have the stable sound-meaning connection of conventional words. At the same time these productions often have adult-like timing characteristics. The syllable shapes of this phase are CVs, often reduplicated. For example [ma], [mama], [dadada], [gaga] (Nakazima, 1962; Smith and Oller, 1981). The phoneme repertoire includes stops, nasals, and glides (usually labials and coronals [Vihman, Macken, Miller, and Simons, 1981]).
2. Early words in English (1;0-1:6): The second stage/phase involves inception of meaning and growth of vocabulary repertoire, up to approximately 50 words. A feature of this phase is simple syllabic structure, for example CV, CVC, or CVCV (Ferguson, 1978). It is also distinguished by a relatively limited repertoire of sound segments, for example, stops such as /t/, /d/, /ʔ/, /p/ /b/, nasals e.g., /m/, /n/, glides /w/, /h/ and vowels /ʌ/, /a/, /i/, /ə/, /u/, /æ/, /o/ (Stoel-Gammon and Cooper, 1981). This means early acquisition of the following features:
    a. Manner: [+consonantal], [-consonantal], [-continuant], [+nasal], ([+continuant] for vowels)
    b. Place: [Labial], [Coronal, +anterior], and ([Dorsal] for vowels and /w/).

c. Laryngeal: [voiced] (although it may not show both contrasting values) and [+spread glottis] for /h/.

3. Phonemic Development Phase for English (1;6 - 5;0): This third phase is described as continuing from first words and developing towards more adult-like articulation (Stoel-Gammon and Dunn, 1985). Word structures that continue to develop in this period are, for monosyllabic words, CV(C). Other monosyllabic words are ranked next. Two-syllable words are ranked fourth in the developmental hierarchy. In the fifth and sixth rank come VC and V. The child starts to produce complex multisyllabic words with consonant clusters towards the end of this period.

Smit (2007) compares research by Templin (1957), Prather, Hedrick, and Kern (1975), Arlt and Goodban (1976), and Smit, Hand, Freilinger, Bernthal, and Bird (1990), who used different criteria for acquisition. The following segments appear to be acquired by age 3: /p/, /m/, /h/, /n/, /w/, (/b/), with some authors observing /ɹ/, /l/ and /s/. From 3;6 - 5;0, additional consonants agreed upon were /d/, / k/, /g/, (/f/), (/j/).

Table 1.2 English acquisition

Segment	Ages	No. of Studies	Ages	No. of Studies
/θ/	4-5	2	6-8	2
/ð/	4-5	3	7	1
/s/	3-4;6	3	6-7	1
/s/	3-4;6	3	7-9	1
/z/	4	2	7-9	2
/ʒ/	4	2	7	1
/tʃ/	3;6-4;6	3	6-7	1
/ʤ/	3-4;6	2	6-7	2
/l/	3-4;6	2	5-7	2
/ɹ/	3-5	3	8	1
/v/	3-6	No agreement		

Note. This table summarizes Smit (2007, p. 133).

Following Grunwell (1985) and Stoel-Gammon and Dunn (1985), phonological processes were observed as follows during this period of development:

Up to age 3:

a) reduplication
b) harmony (assimilation)
c) final consonant deletion (FCD)
d) cluster reduction (CR)
e) fronting (velar fronting, depalatalization)
f) stopping of fricatives
g) gliding (of liquids primarily)
h) context-sensitive voicing.

After age 3:

a) no harmony or reduplication (in shorter words)
b) no FCD (in shorter words)
c) epenthesis in clusters
d) more limited cluster reduction (CR)
e) limited stopping
f) gliding of liquids or vocalization in codas
g) place changes such as labialization of /θ/ → [f] and depalatalization
h) some final devoicing.

In terms of vowels, at the ages of 3 and 4 the percentage of correct usage of vowels was 100% at the age of 3, and slightly regressed at the age of 4 (Irwin and Wong, 1983).

4. Stabilization of the phonological system for English (5;0 - 8;0) (see table 1.2): At this final stage the phonemic inventory is completely acquired; the last segments to be acquired for English typically are /v/, (/θ/), /ð/, /s/, /z/, /ʃ/, /ʒ/, /tʃ/, /dʒ/, /ɹ/ (Sander, 1972; Smit, 2007, p. 133). Advanced word structures stabilize, for example, words with weak initial stress or complex clusters (Sander, 1972; Grunwell, 1987). Once the child is learning writing and reading he will be exposed to more phonemic awareness skills such as word syllabification, and phoneme segmentation.

From Englih norms, phonological development data were not presented in the light of nonlinear phonology particularly for word structure.

1.5.2 Monolingual Arabic Phonological Development

The focus of this section of the paper is on monolingual Arabic phonological development, with the aim of comprehensively investigating the literature available on that topic.

No data are currently available regarding word structure development for monolingual Kuwaiti Arabic-learning children. However, a Kuwaiti Arabic-English bilingual child (Ayyad, Bernhardt and Stemberger, 2006), aged 2;4, produced words of up to four syllables, showing mastery of stress patterns such as (s)wSw and Swsw. Word shapes for the child included codas, vowel length distinctions, medial geminates and sequences, and word-initial clusters (with word-final cluster targets in the words elicited). Dyson and Amayreh (2000), although focusing primarily on segmental acquisition in Jordanian Arabic, observed low percentages of syllable deletion, coda deletion and sequence simplification in their sample of 2- to 4-year-old children (less than 5-10% of such patterns by age 4). Thus, structurally

complex words can occur fairly early in Arabic development, with simplification patterns resembling those for other languages. Much more information is needed on this topic, however.

Although the research literature covering monolingual phonology is very rich in English it has been only minimally covered in other languages, including Arabic. In terms of Arabic, the reasons for this may be:

1. the existence of multiple dialects across the Arab world;
2. variations between spoken and written language;
3. the general lack of research into language acquisition in the Arab world.

So far, most of the available research focuses on monolingual Jordanian and Palestinian Arabic speakers (Amayreh, 2003; Amayreh and Dyson, 1998; Dyson and Amayreh, 2000); with some work on Egyptian Arabic (Ammar and Morsi, 2006; Omar, 1973) described in the following sub-sections. Because there are so few papers available, the purpose and method of each will be discussed individually first by dialect; then results will be compared across the studies in order to be able to compare the Arabic and English data.

Jordanian and Palestinian Arabic

A number of studies have been conducted by Amayreh, Dyson and colleagues, looking at early, intermediate and later phonological development for Jordanian and Palestinian Arabic. An overview of the ages and methods of each study is presented here with results summarized in 1.5.3. For the youngest ages, Amayreh and Dyson (2000) studied inventory development in children under age 2. Spontaneous speech samples were audio recorded using a high quality cassette recorder and PZM microphone from 13 Arabic-speaking children: six boys and seven girls between the ages of 14–24 months who were normally

developing. The Shriberg, Kwiatkowski and Hoffman (1984) transcription method for spontaneous samples was used for the study. These procedures involve narrow transcription of words by two or more researchers. Transcriptions from each researcher are compared to resolve any disagreement. The first 100 utterances were transcribed. The samples were investigated for:

- consonant inventories in four word positions: word-initial, word-medial (syllable-initial and syllable-final) and word-final;
- the frequency of occurrence and hierarchy of consonants and the consonants preferred by some of the children;
- the frequency of occurrence of vowels.

A larger-scale 'normative' study looked at children from 2;0-6;4 (Amayreh and Dyson, 1998). This paper investigated the acquisition of the Arabic consonant inventory as spoken in Jordan with the goals of determining:

Q1. The percentage of children producing each consonant correctly at each level of the nine age levels in the study (within and across word positions).

Q2. Ages at which children reached customary production (50% accuracy), acquisition (75% accuracy) and mastery (90% accuracy) for individual consonants.

A further evaluation rated the consonants as standard or acceptable variants of production.

Speech samples in response to a 58-word picture set were audiorecorded from 180 monolingual, normally developing children divided by age into nine groups, with 10 boys and 10 girls per group. This study, although important for Jordanian Arabic, leaves some questions. The authors did not clearly explain the criteria used for defining *customary production, age of acquisition* and *mastery,* i.e. whether it was within or between

participants, and why they chose those particular criteria. Moreover, the study did not sufficiently evaluate what was indicated by *standard* and *acceptable*.

In order to look at the children's phonological patterns more closely, in another study, Dyson and Amayreh (2000) investigated phonological mismatches and sound change patterns in typically developing Arabic-speaking children between the ages of two and four. The study divided the children into five age groups, each group consisting of ten children, five of each gender. The study used the same 58-word picture naming articulation test and audio-taping and transcription methods as in Amayreh and Dyson (1998). The children's samples were examined in order to determine:

- the percentages of consonants that showed mismatches with the adult targets, and which deviated from Educated Spoken Arabic (ESA);
- the phonological processes or patterns observed.

One comment on this study relates to the Educated Standard Arabic against which the children's phonology was compared: the sample was of preschool-age children, a group unlikely to use ESA, and so it is unclear why the authors chose to examine their productions against ESA. Secondly, it was not clear whether this study included the same children or a partial group of the 180 children of the previous 1998 study.

In a more recent study, Amayreh (2003) followed up on the previous two studies, presenting normative data on the acquisition of 10 *late* Arabic consonants which had not been acquired by the age of 6;4, showing the error patterns and sound changes occurring during acquisition of those late consonants. A sample of 60 randomly selected Jordanian Arabic-speaking children were tested. They were equally divided into two cross-sectional groups, with 15 boys and 15 girls per group. Group 1 ranged in age from 6;6 to 7;4, and

Group 2 ranged from 7;8 to 8;4. The word list comprised 80 words elicited by picture naming and/or reading. The first 58 words were those used in the previous two studies (Amayreh and Dyson, 1998; Dyson and Amayreh, 2000) plus an additional 22 words to improve greater test accuracy and also to better monitor the frequency of occurrence of the consonant sounds in Arabic (Amayreh, Hamdan, and Fareh, 1999).

Amayreh administered the test, collecting audio-taped responses using a Marantz PMD 221 tape recorder with a lapel microphone and using narrow transcription techniques for each sample, with reliability at over 96%.

In summary, for Jordanian Arabic, data have been collected from over at least 200 children between the ages 1 and 8, with small sub-divisions by age group. It is not clear exactly which children were in each of the studies or whether some of the data were from the same children across studies. Transcriptions were done from audiorecordings, with reliability calculated and disagreements resolved. Both inventory and relational analyses were done, in order to determine different ages of acquisition for consonants and patterns observed. The results of these studies will appear in the summary at the end of this sub-section.

Cairene Egyptian Arabic

Ammar and Morsi (2006) discuss the acquisition of Egyptian Arabic phonology, focusing on two studies, the first of which describes typical development of the phonology of Egyptian children between the ages of 3 and 5, and the second of which focuses on the speech of children with protracted phonological development.

They also provide information on the characteristics of Cairene Egyptian Arabic (CEA) phonology. This dialect has 27 consonants, including primary emphatic phonemes /t$^{\varsigma}$/, /d$^{\varsigma}$/, /s$^{\varsigma}$/, /z$^{\varsigma}$/, which are unique to Arabic, and, according to the author's definition, eight vowels,

three short /i/, /a/, /u/ and five long /iː/, /aː/, /oː/, /uː/, /eː/. The phonemes /q/ and /ʒ/ seem to be of a lower frequency than in other Arabic dialects. Syllable shapes in CEA number five only; light ones are CV, CVC; the heavy syllables are CVV, CVVC and CVCC.

The first study was conducted on 36 typically developing children between the ages of 3 and 5, divided into two groups:

- Group 1: age 3–4 years, with five boys and five girls, and
- Group 2: age 4–5 years, with 13 boys and 13 girls.

The stimuli made up a 228-word list targeting the 25 consonants phonemes with two phonemes, /q/ and /ʒ/, excluded. Words were presented to the children as colored pictures or real objects and the sessions were tape-recorded using a high quality tape recorder with low noise quality tape for later transcription. A live transcription was done during the testing session and recordings were used for later transcription also. Reliability was not mentioned. The relational analysis approach was used in the study to determine substitutions and phonological processes.

Another paper by Abou-Elsaad, Baz, and El-Banna (2009) was to develop a speech test for Colloquial Egyptian Arabic CEA. It was a picture-naming test designed for the Mansoura Arabic Articulation Test (MAAT). The test was presented to 100 normally developing Arabic-speaking children at ages 42-70 months. Nothing was reported concerning the findings; however the word list consisted of 106 pictures to elicit all possible consonants across words positions: initial, medial and final. This paper was directed towards establishing a speech test rather than determining facts of phonological acquisition.

1.5.3 Summary of Arabic Phonological Development

1. **Pre-linguistic phase (0;0-1;0):** None of the studies above addressed the prelinguistic period.
2. **Early words (under 2;0):** Results from Amayreh and Dyson (2000) showed that the number of consonants in the children's phonetic inventories ranged from seven to 18, with a mean of 11 for their 13 children under 2 years of age. These consonants were: labials /b/, /m/, /w/, /f/, coronals /θ/, /d/, /t/, /n/, /s/, /z/, /l/, ʃ/, /j/, velars /k/, /g/, and gutturals /ʔ/, /χ/, /ħ/, /h/ and /ʕ/. These segments imply the following features (at least some children showing most of the features for Arabic as present if not fully acquired):
    a. Manner features: [+consonantal], [-consonantal], [+lateral], [+nasal], [-continuant], [+continuant] (and [-sonorant]), [+sonorant].
    b. Laryngeal features: [+voiced] obstruents, [-voiced] obstruents, [+spread glottis] and [+constricted glottis]
    c. Place features: Labial, Coronal [+anterior], Coronal [-anterior], Coronal [+grooved], Coronal [-grooved], Dorsal and ([Pharyngeal]).
3. **Phonemic development phase 2;0 - 6;4 and older:** This period as described by the various authors studying Arabic is longer than in the Stoel-Gammon (1994) description of the period of English phonemic development, because the English period goes to age 6. In terms of word shapes, the studies found CV, CVC, and CVCC to be common. The authors observed three omission patterns for word shapes: syllable deletion, final consonant deletion and sequence reduction. The first two did not exceed 10% and their frequency of occurrence decreased to less than 5%

towards the older ages (Dyson and Amayreh, 2000). More common was consonant sequence reduction, which decreased from 17.2 % to 10.7% over time. Because the children did use medial consonants, they were clearly using words of two or more syllables but no detail is given on the longer word shapes.

Consonants and Consonant Feature Inventories

Amayreh and Dyson (1998) define early consonants as being acquired before the age of four. Early standard consonants, according to the authors, comprised four non-emphatic stops: /b/, /t/, /d/, /k/; the non-emphatic fricatives /f/, /ħ/; nasals /m/, /n/; and the approximants /l/ and /w/. This would comprise the manner features [consonantal], [-continuant], [+continuant] and [-sonorant], [+sonorant], [+lateral], and [+nasal], the laryngeal features [+spread glottis] and [voiced] and the place features [Labial], [Coronal, + anterior], [Dorsal] and [Pharyngeal].

Intermediate consonants were acquired between the age of four and six according to the 1998 study, and included the non-emphatic fricatives /s/, /ʃ/, /χ/, /ʁ/ and /h/. The rhotics, both trilled and tapped, also appeared at the intermediate stage. This would mean the increase in use of manner features [+trilled], [+continuant] and [-sonorant], the laryngeal features [+spread glottis] with addition of the place features Coronal [+grooved] and [-anterior] and an increase in [Pharyngeal] use.

Intermediate acceptable (non-standard) fricatives were emerging: /θ/, /ð/, /ðˤ/, /z/, /s/, /ʤ/, /ʕ/. There were no signs of affricates at this point. This would mean an increase in use of manner features [+continuant] and [-sonorant], the laryngeal features [+voiced] and the place feature [Pharyngeal] plus the addition of [Coronal, -grooved].

In the Egyptian Arabic sample, Group 1 (3-4 year olds) revealed mastery of acquisition of 13 phonemes (similar to the Jordanian Arabic sample): labials /w/, /m/, /f/, coronals /t/, /n/, /l/, palatals /ç/ and /j/, velar /k/, and gutturals /χ/, /ħ/, /ʔ/, and /h/. The rest of the phonemes were in customary production, which the authors define as correct production of phonemes in 50-80% of the responses. Group 2 (ages 4-5) showed mastery of 14 phonemes, the same as those mastered by Group 1, with the addition of /ʕ/, and customary production of the remaining phonemes.

As a final summary note in terms of features for this period of acquisition, [+consonantal], [-consonantal], [-continuant], [+nasal], [-voiced], [+spread glottis], [Labial] and [Coronal +anterior] were least challenging and earliest, and the features for affricates [-continuant]-[+continuant], the trilled /r/, [+lateral], [Coronal +grooved], [Coronal, -grooved] and [Pharyngeal] were most challenging.

Phonological Patterns Observed in Periods of Phonemic Acquisition

In terms of match with the adult target, Amayreh and Dyson (1998) noted that at about the age of 2;0-2;4, 40% of the consonants did not match the target, either because of mismatches or changes from ESA. Theses changes had been reduced by about one-half by age 4;0- 4;4. No gender-specific differences were detected throughout the study.

In terms of phonemic substitution patterns, to avoid grooved consonants, children tended to omit them or substitute a non-grooved consonant (Dyson and Amayreh, 2000). This pattern decreased from 24.4% to 12.5% towards the age of 4;0 – 4;4. For place of articulation another interesting pattern was observed: the fronting of back consonants. Both the velar stop /k/ and the uvular stop /q/ were sometimes fronted by the youngest participants. At the same

time the uvular fricatives /9/ and /ʁ/ remained accurate. Dorsal consonants are often difficult at this early age in general because visual information is almost absent for these speech sounds. Phonological development often starts with /t/, /d/, then develops to /g/, and /q/ (front to back development [Dyson and Amayreh, 2000]). However, the reason the uvular fricatives might be easier than the stops is because they require less precision as orosensory targets. Another equally important factor is the spoken colloquial dialect in Jordan; some dialects there tend to back the stops and replace them with the glottal stop /ʔ/, making them less frequent in the input. This fronting pattern disappeared by the age of about 3;6.

Dyson and Amayreh (2000) observed a further four patterns arising as a result of dialectal variation (Jordanian Arabic) and developmental process:

1. spirantization (stop > fricative);
2. glottal replacement;
3. loss of the secondary 'emphatic' or 'pharyngealized' articulation (most common);
4. stopping of fricatives and affricates.

A variety of processes were found in the Egyptian study similar to those of Dyson and Amayreh (2000). Ammar and Morsi (2006) reported the following processes for Group 1(younger group): de-voicing, de-emphasization, and cluster simplification, di- and multisyllabic simplification. Additionally, 50% of participants showed deviation of /r/ and sibilants. About 20% of the participants showed velar fronting and final consonant deletion. Group 2 revealed the same results except for velar fronting, which scored 5% or less, and final consonant deletion, which did not appear. Both groups showed one to eight phonological processes per child.

Medial Consonants: A Note

An interesting finding of the Amayreh and Dyson (1998) study was that medial consonants were produced more accurately than initial and final consonants, but there were no significant differences between the initial and final positions. In order to determine if the medial position was a better position for production, further analysis was carried out on consonant classes such as stops, fricatives, and sonorants. As observed among six out of nine groups, analysis revealed that there was better production accuracy on medial stops than on initial or final stops. Accuracy was even greater for fricatives and sonorants words medially: in eight out of nine groups the medial fricatives were produced more accurately than the other positions and medial sonorants had the highest accuracy in the production of all nine groups. The surrounding vowels in intervocalic position perhaps facilitated higher production of the [+continuant] fricatives and sonorants (plateauing, as described in Bernhardt and Stemberger, 2002). (An implication suggested by Amayreh and Dyson [1998] is that normally developing children should produce medial consonants correctly; otherwise, this will imply a delayed or disordered phonology for Arabic.) However, no attention was paid to word stress, which may have influenced medial consonant production.

1.5.4 Late Acquisition: Stabilization of the Phonological System

According to Amayreh and Dyson (1998), late consonants were acquired after the age of six. Late consonants included the emphatics (pharyngealized consonants) and the rest of the pharyngeals (Amayreh, 2003). In the older children, only one consonant fit the most difficult criterion, /q/, whereas almost half of the 28 consonants matched their ESA targets. The study found that the ESA consonants, /dˁ/, /q/, /z/ and /ʕ/, were acquired at age 6;6 -7;4. By 7; 8 –

8; 4, the /tˤ/ had also appeared. All late segments/consonants incorporated the same features as at the intermediate stage, except for the unique Arabic feature, [Pharyngeal].

The coronals /ð/, /θ/, /ðˤ/, /sˤ/ and /ʤ/ were not fully acquired even by the oldest age group, (8;4), even though they were produced in an acceptable form by most of the participants. The author justified the late acquisition with two factors: low functional load related to late and inconsistent exposure and the degree of difficulty of articulation (markedness) for some consonants. Amayreh (2003) did not mention whether children dentalized their coronal fricatives (lisping).

The next section will provide a comparison of Arabic and English phonological development as a basis for the questions for this dissertation and the discussion of results.

1.5.5 Comparison of Arabic and English Phonological Development

Early Words

The authors of the Arabic studies (particularly Amayreh and Dyson) compared their findings with the earlier studies of Sander (1972), Ingram (1989b), Jakobson (1968) and others. Key differences are in italics.

For phonetic inventory in *early words*, the Amayreh and Dyson (2000) study showed that there are many characteristics similar to acquisition in English. However, there was an unexpectedly large inventory of consonants and vowels. *In spite of the young age of the Arabic participants, a larger inventory was observed compared with studies of acquisition in other languages.* The glottal stop appeared in all word positions and was a landmark in production for these children. The appearance of the consonants /d/ and /t/ conforms to the findings relating to world languages. However, *the bilabial stop /b/ was less common*

compared to what has been reported in English. Glides were present in the findings of the study, just as in other languages, with the glide /j/ showing higher frequency than /w/.

Phonemic Development Phase

In terms of phonemic acquisition, some of the findings supported Jakobson's (1961) proposed universal theory of the patterns of acquisition. For example, stops were acquired before fricatives and front consonants preceded back ones. Each stage supported a study in the literature. On the other hand, the relatively early acquisition of the uvular fricative /χ/ supports *the functional load hypothesis* of Ingram (1989a) or later work (e.g., Beckman and Edwards, 2000), which states that order of acquisition can also reflect frequency of input of a phoneme. The /χ/ is frequent and contrasts with many other sounds in Arabic: fricatives, stops, and sonorants.

In further discussion of their 1998 study, Amayreh and Dyson compared their data with those reported in other languages. For example, in comparison with studies by Dyson and Paden (1983) and Khan and Lewis (1986), final consonant deletion in Arabic was less common than in English. However, in comparison with Preisser, Hodson and Paden (1988) final consonant deletion appeared more common than in English.

Comparisons with Ingram, Christensen, Veitch, and Wagner (1980), Hodson and Paden (1981), Khan and Lewis (1986), and Preisser et al. (1988) show stopping of fricatives and stridency deletion in Arabic to have occurred with the same frequency as in English. According to a study of velars in English by Hare (1983), fronting of back consonants in Arabic also occurred with similar frequency to English.

According to Amayreh and Dyson (1998), *use of [ɹ] for /r/ was one of the most common patterns among Arabic-speaking children.* Although this pattern was found to occur occasionally in English it was not considered to be a common pattern (Smith, 1973; Dyson and Paden, 1983; Smit, 1993), but it is a common pattern found in other languages, such as Italian, which have a trilled /r/ (Bortolini and Leonard, 1991).

The 1998 Amayreh and Dyson study explains and justifies the reasons for the difficulties and constraints of the phonological issues mentioned above within the framework of three categories:

1. Differences in motoric difficulty among consonants and sound combinations;
2. Frequency of occurrence and functional load of consonants within the languages; or
3. Acceptable free variation within phonemes due to dialects.

In the area of motoric difficulty the authors found that the most difficult consonants were physiologically difficult in their production. Examples of these sounds in Arabic were the emphatics: /tˤ/, /dˤ/, /sˤ/, /ðˤ/and /r/. This finding was similar to reports of difficulties with emphatics in other languages (Olmsted, 1971; Omar, 1973; and Ingram, et al., 1980). It is worth mentioning that consonant clusters were not covered in detail in any of the studies, but difficulty with consonant sequences would also be included under motoric difficulty. The Amayreh and Dyson (1998) study concluded that the most marked segment was typically deleted in a consonant sequence word medially, e.g., /d.r/ → [d], /r.s / → [s] and /r.w/ → [w]. For Arabic-speaking children, abutting consonant sequences were reduced in the same way as for African-American English-speaking children (Stockman and Stephenson, 1981), but in contrast, Arabic-speaking children maintained gemination features. Thus a long consonant

provides a simpler articulatory task than a sequence of dissimilar ones, as reported also by Grunwell (1982).

Late Acquisition

Comparing Arabic and English, the following consonants are generally late acquired by English-speaking children: fricatives /v/, /θ/, /ð/, /ʒ/, /z/, affricate /dʒ/ and liquids /l/ and /ɹ/ (Smit, 2007). They are often acquired between the ages 6 and 8 years (Grunwell; 1985). For Arabic /dˤ/, /q/, /z/, /ʕ/ were acquired at the age 6;6-7;4. The emphatic /tˤ/ was acquired at the age 7;8-8;4. The coronals /ð/, /θ/, /ðˤ/, /sˤ/, and /dʒ/ were not fully acquired by the oldest age group (8;4). For the Arabic late acquisition, late segments were more or less similar to the "intermediate" ones, except for the pharyngeals. Consequently, the findings for both languages look similar (except for the pharyngeals).

The above findings serve as a comparison for results of the current study.

1.6 Evaluation of Phonological Development

As a prelude to formulation of questions for this thesis, the third section of the chapter will address the issue of phonological sampling for the purposes of determining phonological development levels, whether for research or clinical purposes.

For clinical assessment purposes, Kennedy (2007) describes three main groups that clinical assessment instruments fall within: (1) norm-referenced or standardized tests, (2) criterion-referenced, and (3) observational tools. Because the instrument used for this dissertation has the eventual aim of a norm-referenced instrument, I focus only on this type of evaluation procedure here.

Kennedy explains norm-referenced tests as standardized instruments that can be used to compare an individual's performance to the performance of others with similar demographic characteristics such as age and gender (Kennedy 2007, p. 46). This type of test is most helpful for determining the existence of a problem and eligibility for services. McCauley and Swisher (1984) conform with this perspective, adding the fact that when a child's scores falls outside the scores of the individuals in the normative sample, the child may have an impairment in speech and/or language behavior. Because a measurement assigns numbers to the respondents during norm-reference procedures, the *properties* of the numbers are given to the respondents. Consequently, these statistical properties allow the measurer to make meaningful comparisons among participants and then determine the deviation from the normative scores that may reflect a language or other type of communication delay. However, the norm-referenced instruments must meet certain characteristics of measurement in order to be useful, valid and reliable.

Reliability

Reliability is the consistency or steadiness with which a test measures what it is supposed to be measuring (Kennedy, 2007). A reliable measurement instrument gives the same value when the variable is measured more than once in the same time period (McCauley and Swisher, 1984, p. 35). Reliability allows us to make assumptions about the testing through several subcategories of reliability such as inter-rater reliability, test-retest reliability, and so on. Inter-rater reliability is a procedure of "quality assurance" determined when a second examiner re-administers or rescores a test. This step aims to confirm that the performance of the test-taker is not influenced by the examiner's characteristics. It is a strategy through which the objectivity of the test administrator is measured. Test-retest

reliability refers to the stability of the test when taken on two different occasions; the results should be the same or very similar for the same individual.

Validity

Validity refers to the relevance and appropriateness of the interpretations and uses of the test results. Different types of evidence may contribute to overall validity (McCauley and Swisher, 1984): content-related validity, criterion-related validity, concurrent validity, and construct validity. Content validity is the reflection of the test items of the domain or the theories of the discipline: in short, the relevance and the homogeneity of the items and the field of knowledge being tested. The following factors determine content validity: (1) item appropriateness, (2) sample completeness, and (3) the manner of content assessment. Criterion-related validity includes two subtypes of validity: predictive and concurrent validity. Concurrent validity refers to the relationship between two different measures at the same time; predictive validity refers to the future performance of the individual predicted by his/her scores on a measurement. In terms of construct validity, the above types of validity will enhance the validity of a construct if they are strong. In addition, however, the tool must be measured against the theoretical construct on which it is based.

Standardization

Because it is impossible to test everyone in a population, a normative sample from that population must be tested when developing a test. Kennedy (2007) and McCauley and Swisher (1984) propose the following characteristics as necessary for a normative sample:

- The norming sample must be representative; the participants in the norming sample must be of a wide range of the population, maintaining the same characteristics as the projected test-takers. These characteristics include age, gender, race, ethnicity,

socioeconomic background, and geographic distribution reflecting the whole demography. In other words, the sample must cover all sectors of the whole population, representing every minority and majority.

- The number included in the sample must be adequate. It is recommended that a minimum of 100 people be in the sample at each level (for example, age or grade level) (McCauley and Swisher, 1984).
- The norms must be relevant to the nature of the test. That means a test for phonological assessment in Kuwaiti Arabic for normally developing children will be relevant only in the state of Kuwait; it will not help children in Bahrain or Saudi Arabia adequately.
- Descriptive statistics: This is essential in interpreting tests scores and results. Basic concepts such as normal distribution of the scores, mean central tendency and standard deviation from the mean, must be included to help the measurer understand the scores.

Error

Since true scores are hard to determine, there is always a chance of error; therefore, test manuals should provide the standard error of measurement (SEM), i.e. the standard error around a person's true scores. The SEM provides the confidence intervals surrounding the scores. For example, if the individual does the test more than once, his or her scores will be subject to errors. The SEM indicates the confidence interval within which the true score should occur.

Test Norms and Scores

Raw scores are interpreted according to the test norms and are generally converted into derived scores, either developmental (age or grade equivalents) or scores of relative standing (percentile ranks, standard scores, taking standard deviation into account). Further considerations regarding determination of normal or protracted development is discussed below.

1.6.1 Determining 'Normal' Acquisition of Phonology: The Phonological Evaluation

Protracted phonological development**,** according to Bernhardt and Stemberger (1998) is identified when an individual's phonology shows a notable delay in rate of acquisition. Generally, children with phonological impairments show patterns similar to those of younger typically developing children, but produce those patterns for a longer time and in greater frequency. Sometimes they show chronological mismatch, producing some forms at or near age level, and others as those of younger children. Note that some clinicians differentiate between phonological delay and phonological disorder; Bankson and Bernthal (2004), in their text, do not. Their reason for this is that most children in reality do have multiple misarticulations that will fall into both categories.

To determine whether or not a person has normal or protracted phonological development, some kind of phonological evaluation is necessary. Phonological assessment aims to describe and evaluate the speech sound production system of an individual. This can be done in two basic ways:

1. Examining the speech sound system independently of adult targets (independent analysis).

2. Comparing the person's speech with the adult pronunciations within a particular community. This procedure is called the 'relational analysis.'

In some cases a speech-language pathologist may assess dialectal variation. This may be the most challenging component of assessment, where the SLP has to make a decision regarding these characteristics, i.e., if they are reflecting a dialectal variation or a speech disorder. Other evaluations are also typically included, e.g., a hearing screening, an examination of the oral mechanism, additional language evaluation and so on. The focus here is on the phonological sample for the evaluation, with the next section comparing briefly two tools in order to present the breadth of possibilities for such instruments.

A number of tools are available for phonological assessment in English, with some developing tests for Arabic, for example, for Jordanian Arabic by Amayreh (1994), and for Egyptian Arabic, by Abou-Elsaad, Baz and El-Banna (2009). The English instruments include standard 'articulation' tests (such as the Goldman-Fristoe Test of Articulation Revised—Goldman and Fristoe, 2000), phonological patterns evaluations (e.g., the Hodson Assessment of Phonological Processes, Hodson, 2004), both of which are primarily relational analyses, or a recent computerized phonological assessment (the Computerized Articulation and Phonology Evaluation – CAPES, Masterson and Bernhardt, 2001), which allows both extensive relational and independent analyses. This section contrasts two major exemplars for English: the Goldman-Fristoe test, because it was designed to provide a systematic assessment of consonant sounds in English and was standardized for ages 2;00-21;11 years, and CAPES (2001). The latter aims to collect speech samples and analyze articulation and phonology on a Windows-based computer. The authors for CAPES followed the Iowa-Nebraska standardization (Smit, 1993), and thus the test targets word-initial, word-medial,

and word-final consonants and consonant clusters. However, CAPES also evaluates vowels, word length, stress patterns and word shapes. Each of these tools will be briefly evaluated in terms of the criteria described earlier in this paper for test construction as a background for discussion of the tool for Kuwaiti Arabic discussed in the Methods chapter.

The Goldman-Fristoe-2 Tests of Articulation (2000)

The Goldman-Fristoe-2 is a standardized test of articulation designed to provide a systematic assessment of 77 consonant sounds in 53 single English words (2000, p. 35) through picture elicitation. Additional measures include stimulability testing for sounds in isolation, words and sentences. Strengths of this instrument are:

1. The overall standardization sample by size and age range: The test was standardized for ages 2;0-21;11 years in 300 sites nation-wide in the USA. The standardization sample consisted of 1723 female participants, and 1798 male participants.
2. Its efficiency: The authors say that it can be completed within 5-15 minutes.
3. Reliability: The manual of the GFTA-2 states that this test has internal reliability because of the internal consistency or homogeneity of the items or tasks in the test (2000, p. 54). Coefficient alpha is an aspect through which the uniformity is tested, and it ranged between 92-98. Standard Error of Measurement was used to interpret individual scores in this test and confidence intervals were centered on the observed scores, which increases the reliability of the test.
4. Validity: The manual states that the test has content validity because the items sample the targeted domain by including the 25 consonant sounds of American English (2000, p.55). The absence of the sounds /ʍ/ and /ʒ/ was because of their low intervention priority compared with the rest of the consonants. For construct validity the manual

states that the sounds-in-words component measures children's ability to produce consonants and consonant clusters over time (2000, p. 55); evidence of construct validity is the developmental progression of total raw scores and of item scores.

At the same time, the test has weaknesses in many of the same criteria areas.

1. Standardization sample: The whole sample was divided into 11 age groups, with uneven numbers across age groups. A second subdivision for the sample, which adds to the weaknesses of the test, is the regional sub-grouping, which misleads the reader regarding how many people are in each age group.
2. Reliability: Another point of weakness in this test is the examiner's qualifications; they use the term "trained listener", without defining "trained." Thus, inter-examiner reliability could be questionable, especially considering the need to transcribe accurately.
3. Validity: The manual lacks any detailed phonological description (word position, stress patterns, word shapes, vowels) for the targeted words and sentences. The small number of words and the lack of concern for prosodic structure compromise construct validity. The manual also did not provide any discussion of concurrent or predictive validity.

CAPES (2001)

CAPES is the Computerized Articulation and Phonology Evaluation (Masterson and Bernhardt, 2001). It aims to collect speech samples and analyze articulation and phonology on a Windows-based computer. Stimuli are in the form of videos and photographs presented electronically. Relative strengths of CAPES are:

1. The standardization sample: The authors follow the Iowa-Nebraska standardization (Smit, 1993) as a criterion reference. This Iowa-Nebraska standardization study presents comprehensive data about the typical and atypical errors made by English-speaking children when they produced consonant singletons and clusters with emphasis on the mismatching sounds actually used, including both distortions and phonological process errors and the development of the consonant system. The Iowa-Nebraska norms present the ages of acquisition of consonant singletons based on metric based frequency of occurrence, the frequency of mismatches at various ages, and on the scope of phonological process application. The total number of the standardization samples was 1049 participants. The children were divided into 12 age groups from the age of 2 years through the age of 9 years, using 6-month intervals until the age of 6 years, and then yearly from age 7 to 9 years.
2. Reliability: The test is to be administered by speech-language pathologists. Narrow transcription skills are preferred for this type of tool.
3. Validity: CAPES has strong content coverage for phonology. The single-word elicitation component targets word-initial consonants, word-medial and word-final consonants and, consonant clusters, stress patterns, and word shapes. The test has two parts; the first is the phonemic profile, a primary analysis of the client's production of 46 words. The profile acts as a screening component and needs 10-15 minutes administration time. Results of this profile automatically determine the appropriate individualized phonological evaluation (IPE) for the client. The second part is the Individualized Phonological Evaluation (IPE) and consists of 20-100 additional words that enable in-depth analysis of the client's production. This time for

administration for the IPE varies according to each individual sample. A 'connected speech' component allows open entry, either as single words or conversational speech (in any language). Some of the adult targets in the connected speech module are in the program database, whereas others have to be entered each time.

For analysis, CAPES scans all phonological aspects on the level of the individual word and connected speech both for independent and relational analyses. The user can look at word shapes, stress patterns, syllable lengths, word lengths, and production of consonants and vowels across word positions. Phonological processes are also included.

Weaknesses of CAPES as an instrument are in the areas of standardization, reliability and validity.

1. Standardization sample: First, it is only criterion-referenced. It does not have its own norms; it relies on the Iowa-Nebraska norms.
2. Reliability: There are some technical deficiencies in the software, which need to be taken into consideration, and thus add to the time for analysis and accuracy of the results.
3. Validity: The absence of concurrent and predictive validity results in a decrease in the test's clinical usefulness in the field of speech-language pathology even though it has sufficient content and construct validity in terms of phonology. Furthermore, no item analysis was done, reducing content validity.

The amount of effort devoted for constructing each of the tools (as exemplars of such tools) appears substantial and is not in question. Both tools contribute to the assessment of phonology in different ways and have different purposes and uses. For research purposes and extended analysis for comprehensive phonological aspects, tools such as the CAPES shall be

the first option. A test such as the Goldman-Fristoe-2 will be for assessing an individual's articulation of consonants as a norm-referenced test (for determining eligibility of services, for example).

1.7 Arabic Phonological Evaluation and the Questions for this Thesis

Turning to Arabic, the assessment of phonology is a relatively new field for research. Arabic is an almost untouched language for speech and language assessment and measurement instruments. The issue of dialects is a great challenge for standardizing an assessment tool for pre-school ages across Arab-speaking countries. For standard Arabic there is a potential for such standardization, but only for school-aged children, who are taught the standard dialect. To address dialects for preschool children, individual speech tests are needed to meet the needs of every Arabic country. A review of tools in English and McCauley and Swisher (1984) shows that the following points will be important in developing a tool for Arabic, i.e., to:

1. Construct the tool on the basis of strong theoretical grounds
2. Address all phonological aspects in Arabic
3. Meet the required psychometric characteristics (standardization, reliability, validity)
4. Represent a wide demographic pool
5. Include a screening tool
6. Include individuals with phonological impairments in the norming sample
7. Make it easy to administer and reasonable in time consumption and
8. Cover a wide age range.

This will entail challenges for Arabic because it is still developing in language acquisition research in general and phonological acquisition research in particular. To date, the major

study on phonological development of Arabic remains Amayreh and Dyson's normative study (1998); however, Amayreh and Dyson did not use frameworks of modern phonological theory in terms of describing word shapes, word lengths, and stress patterns, which gives this project an untouched area to work on.

To date, no information is available about the phonological development of normally developing Kuwaiti children. Moreover, there are no speech and language assessment tools for Kuwaiti Arabic. Although the state of Kuwait has provided various programs for children with developmental delays in the public school system, e.g., Down syndrome and autism, no intervention programs are available for children with speech delays. Therefore, there is a clear need for a normative study of speech development (as a basis for an assessment tool) for the Kuwaiti community. The thesis project was consequently devoted towards developing the basis for a speech assessment tool to assess speech production skills among Kuwaiti Arabic-speaking children. The decision was made to test 4-year-olds only because most research has agreed on the fact that the child at the age of four years has mastered many of the ambient speech sounds. Thus, this is the optimum age to determine any speech delays and consequently determine the need for intervention before entry into elementary school.

This project adopted the nonlinear phonological framework for description and analysis (primarily using the approach of Bernhardt and Stemberger, 1998). Nonlinear phonology describes phonological form in terms of a hierarchy of phonological elements as well as a linear sequence. This hierarchy starts at the level of phrases (see Figures 1.1-1.4) and ends up with individual features. The framework thus provides a comprehensive approach for phonological assessment and intervention at a variety of phonological levels that goes beyond identification of error patterns as in a phonological process analysis. For the present

study, both inventory and relational information is presented for consonants, consonant features, CV structure and word length. Vowels, stress and timing units were not analyzed in the present study because they require in-depth acoustic analysis and further development of transcriotion systems for Arabic, both of which were beyond the scope of the study at this time. The other advantage of using a nonlinear approach to analysis was in order to be able to compare Arabic with a variety of languages in an ongoing crosslinguistic study.

The project addressed the following research questions, with predictions reflecting the literature on Arabic and English phonological development.

1.7.1 Research Questions

Question 1: What are 4-year-old-Kuwaiti children capable of in terms of speech/ phonological production (inventory) for:

1a. Word structure: word shapes, lengths and stress patterns

Predictions: Based on Ayyad et.al (2006), Amayreh and Dyson (1998) and Ammar and Morsi (2006), it is predicted that 4-year-old children will have acquired the following

- Word shapes: CV, CVC, CVCC, CVV, and CVVC.
- Word lengths: Unknown but because of Ayyad et al. (2006), possibly up to four syllables.

1b. Consonants and manner, laryngeal and place features

Predictions: According to Amayreh and Dyson (1998) for Jordanian Arabic, early consonants (before the age of four), comprised four non-emphatic stops: /b/, /t/, /d/,

/k/; the non-emphatic fricatives /f/, /ħ/; nasals /m/, /n/; and the approximants /l/ and /w/. This would comprise:

- Manner features [consonantal], [-continuant], [+continuant] and [-sonorant], [+lateral], and [+nasal]
- Laryngeal features [+spread glottis] and [voiced] and
- Place features [Labial], [Coronal + anterior], and [Dorsal] and ([Pharyngeal]).

Between the age of four and six according to the 1998 study, the inventory also included the non-emphatic fricatives /s/, /ʃ/, /χ/, /ʁ/ and /h/. The /r/s, both trilled and tapped, also appeared at the intermediate stage. Because children in the current study were over 4, some may also have these consonants. This would mean the increase in use of:

- Manner features [+continuant]-[-sonorant], and [trilled]
- Laryngeal features [+spread glottis] and [Pharyngeal] and
- Place features Coronal [+grooved] and [-anterior].

1c. Consonant clusters in morphophonemic alternations (plurals)

Predictions: Consonant clusters: No previous data have been reported, but reports by Bernhardt and Stemberger (1998, 2000) suggest there will be interactions between phonology and morphology.

Question 2: What developmental patterns and constraints appear in the speech of 4-year-old-Kuwaiti children for:

2a. Word structure

Predictions: Based on Ayyad et. al. (2006), Amayreh and Dyson (1998), and Ammar and Morsi (2006) it is predicted that the following developmental patterns will appear in the children's phonologies at age 4: syllable deletion, cluster reduction, coda deletion.

2b. Consonants and their features

Prediction: As with Dyson and Amayreh (2000), it would be expected that to avoid grooved consonants, children would omit them or substitute a non-grooved consonant with a gradual decrease over the 5th year. For place of articulation, fronting of velar and uvular stops might be expected, while children produced accurate uvular fricatives. Other patterns that might emerge are the following:

- Stopping of fricatives and affricates (manner – less expected)
- Spirantization (stop > fricative) this occurs between vowels (manner – less expected)
- Glottal replacement (place/manner?)
- Loss of the secondary 'emphatic' or 'pharyngealized' articulation; (manner and place - common).
- Use of [l] for /r/ (manner - common)

Question 3: What are the necessary parameters and criteria for a phonological assessment tool for 4-year-olds, based on the results of the previous question, i.e., expected level of mastery for the various categories identified above for the age based on measures of central tendency for the identified variables?

Note that the study provides the basis for test construction and does not represent test development. However, basic criteria can be determined.

2 METHOD

This chapter will present the research methodology used to derive benchmark information about phonological development of 4-year-old Kuwaiti Arabic speakers. In order to address the research questions the procedures below were followed.

2.1 Participants

The participants were 80 typically developing monolingual Kuwaiti children, age range 46-62 months (3;10-5;2) years. The mean age was 53.1 months (SD 4.2), with 38 males and 42 females. Four-year-olds were tested because by this age at least for English (Smit et al.1990) and Jordanian Arabic (Amayreh and Dyson, 1998), the phonological repertoire is almost complete in terms of acquisition; thus, it is the age where intervention would be essential in order to remediate any delayed speech before school age. Children from the kindergarten schools and from the six school districts in the state of Kuwait were recruited to participate.[1] Our intention was to recruit children whose parents were both Kuwaiti citizens, but three children with Saudi mothers were included as well (who may have used slightly different lexical items or pronunciations). The participants were recruited by age group and gender: a younger age group (43 participants) age range 46-54 months (mean 50.3 months, SD 2.5 months), and an older age group (37 participants), age range 55- 62 months (mean 57

[1]An initial letter was sent to the Ministry of Education in the State of Kuwait by way of requesting the participation for research approval. Upon that, the Ethics consent was obtained from the University of British Columbia and translated into Arabic. Another letter for the study abstract was written and translated into Arabic. Both letters were submitted again for the six school districts and administrations, which in turn enclosed them with a memo and mailed them to all kindergarten schools' principals providing me with a permit for research. Once I visited the school all of the above mentioned letters and memos were received by the ministry's internal confidential express post/ mail. After a short meeting with the school staff the intended participants were chosen from the school records system according to their ages and typicality. Next, the translated consent form with the study abstract was given to the participants under the condition of returning it the following day. Parents were asked to comment on ear infection or developmental difficulties. Then the schools were to contact me upon the return and the completion of the forms. An appointment based on that was determined with the school staff in order to test the children.

months, SD 2.2 months). The younger and the older age groups were formed based on the midpoint of the age range (although the younger group was over a 9-month age range and the older over an 8-month age range).

2.2 Testing Session

A single-word Kuwaiti Arabic speech sample was collected in Kuwait from each child by the author, a native speaker of Kuwaiti Arabic. Testing time for each child averaged 45 minutes. At the beginning of the data collection procedure, the sessions took 35-45 minutes. Towards the end, the sessions lasted only 18-20 minutes because some participants were very fast. A thank you card was given to the parents, and a sticker to the child after the completion of the testing session.

2.3 Recording Method

Responses were digitally recorded with an M-Audio MicroTrack II 24/96 digital recorder and a Beier TGX 58 microphone. The testing was done in a quiet room in the school to reduce noise on the recording (the directional microphone also helped to reduce noise). The child was 6-8 inches away from the microphone and the sound quality was tested for each child after the demonstration stimuli were recorded. All data were exported from the digital recorder to a laptop, then onto an external hard disk for safe back up.

2.4 Elicitation Procedures

A single word list consisting of 88 words (see below) was created for elicitation. Elicitation started with spontaneous naming of 12 objects. Delayed imitation was requested from the child if s/he did not know the word in a phrase, using a question of the form: “Is this

an X (the target) or a Y?" The child was introduced to the task and a short demonstration with simple trial items was provided. A puppet was used to pick some of the miniature objects in order to "break the ice" with the child and to encourage him or her to enjoy the task. The major task was then a picture naming task with a binder of photographs. The experimenter filled a jar with false coins in order to indicate the number of items completed.

A custom-made word list was prepared for Kuwaiti Arabic. It includes the entire Kuwaiti Arabic segmental inventory, including vowels and diphthongs and a variety of word lengths and structures, and including some morphophonemic alternations. A preliminary version of the list was piloted in Ayyad et al. (2006) and was modified to include a greater variety of words and to eliminate words that are difficult to elicit. The word list includes: 23 monosyllabic words, 50 disyllabic words, 13 trisyllabic words, and two four-syllable words. Consonants were targeted across word positions at least twice. The words are presented in Tables 2.1-2.3, showing the most common pronunciations and acceptable variants used by adults. Note that the list only contains those variants used in our sample. The range of variants per word is not known for adult Kuwaiti Arabic. Table 2.1 shows the monosyllabic words and variants.

Table 2.1 Monosyllabic words in the study list with variants

Monosyllabic		Variants						
Tea	tʃai							
To mop	χəm	jiχəm	jχəm	jəχəm	ejχom	ʔəjχəm	ʔiχəm	ʔjχ{ə/ɔ}m
Hand	ʔiːd	plur.	ʔiːdeːn					
Girl	bɪnt	bnajə^{h}	bnəjə	ibnəjə				
House	beːt							
Houses	bjuːt	ʔbjuːt	ʔəbjuːt					
Upstairs	foːg							
Thread	χeːtˁ							

Table 2.1 (cont.)

Monosyllabic		Variants						
Threads	χjuːtˤ	ʔχjuːtˤ	ʔəχjuːtˤ					
Black board	loːħ							
Chewing gum	ʕɛltʃ	ʕɛlk (B)						
Foot	riːl	rɪdʒl	ridʒɪl	ridʒl	ridʒlə			
Plates	sˤ ħuːn	sˤuħuːn	ʔsˤ ħuːn	ʔəsˤ ħuːn	sˤɔħuːn		əsˤ ħuːn	
Pots	dʒduːr	dʒʌduːr	ʔədʒduːr	ʔidʒduːr	ʔdʒduːr	dʒəduːr	dʒiduːr	
Ducks	bʌtːˤʰ	bʌtːˤʰət	bʌtːˤʰæːt					
Cold	bərd							
Noses	χʃuːm	χəʃuːm	ʔχʃuːm	əχʃuːm				
Money	fluːs	ʔfluːs	ʔəfluːs					
Night time	lejl							
An elephant	fiːl							
Mouth	ħaldʒ	ħalg (B)	"our mouth" ħaldʒnə					
Bed	sriːr	səriːr	ʔəsriːr	seriːr	sɛriːr			
Dog	tʃɛlb	kɛlb (B)						

Note. B = Bedouin.

The disyllabic word length represents the largest portion of the word list. Most acceptable variants involve vowel/syllable deletion.

Table 2.2 Disyllabic words in the study list with variants

Disyllabic		Variants				
Feet	riˈuːl	ʔriˈuːl	ʔruːl	ʔərˈuːl	ʔ(ə)riˈuːl	ʔərˈdʒuːl
		ʔrjuːl	rdʒuːl			
Story	ˈqəsˤːə					
Carrots	ˈdʒɛzər					
Teeth	ʔaˈsnaːn	snuːn (B)				
A key	mɪfˈtaħ					
Kuwaiti Food	matʃˈbuːs					
Medicine	ˈduwa					
Motor Bike	ˈsejkəl					
Dirty	ˈwʌsˤəχ					
Hand Bag	ˈdʒəntˤə	ˈʃəntˤə “Saudi dialect”				
Down Stairs	ˈtaħat	ˈtəħt				
Oregano	ˈzəʕtər					
Sheep	χaˈruːf					
Hair	ˈʃaʕar					
Rabbit	ˈʔərnəb					
Banana	ˈmoːzə	moːz (Pl)	ˈ			
Sorry	ˈʔæːsɪf	ˈʔæːsfə(ʰ)				
Nice/Sweet	ˈħɛlu					
Camel	beˈʕiːr	ʔbˈʕiːr	ʔəbˈʕiːr	bˈʕiːr		bəˈʕæriːn(Pl)
Air	ˈhəwə					
Eating	ˈjaːkəl					
Nose	ˈχaʃəm					
Fish (Plural)	ˈsɪmətʃ	ˈsɪmək (B)				
Stand. Arabic	ˈsəmək					
A fish	ˈsmɪtʃə	ʔˈsmɪtʃə	ʔɪˈsmɪtʃəʰ	ʔəˈsmɪtʃə(ʰ)	ʔəˈsmɪkə (B)	
Stand. Arabic	ˈsəməkəʰ					ˈsmɪkə(ʰ)
Hairscarf	ħaˈdʒaːb	ʔəħˈdʒaːb	ʔħˈdʒaːb	ʔaħˈdʒaːb	ʔəħaˈdʒaːb	əħˈdʒaːb
K.G.	ˈrawðˤə					
Pearl	ˈluːluː					
Grapes	ˈʕa(j)nəb	ˈʕi(j)nəb				
Tomato Sauce	daˈqːuːs					

Table 2.2 (cont.)

Disyllabic		Variants				
Boy	ˈwalɪd					
Spoon (sg)	ˈgəfʃə					
(Bedouin)	mɪlˈʕəgə					
Plate (sg)	ˈsˤaħan					
Ball	ˈkurə	ˈkɔrə				
Cheese	ˈdʒɪbən					
Finger	ˈsˤəbəʕ	ˈsˤɔbəʕ	ʔˈsˤbəʕ	ʔəˈsˤbəʕ	ʔəˈsˤ aːbəʕ (Pl)	
Comb	ˈmɪʃətˤ	ˈmɪʃtˤ	ˈmiʃtˤ			
A chair	ˈkirsi					
Pot (sg)	dʒɪdər	gɪdər				
Sock	ʔədˈlaːʁ	ʔədˈlaːq	dˈlaːʁ		ˈdlaːʁət (Pl)	
Mango	maŋgə					
Bicycle	ˈgaːri					
Duck	ˈbʌtˤːə					
This	ˈhaːðə					
Straws (Pl)	maˈsˤːəsˤ					
Bread	ˈχəbəz	ˈχɔbɔz				
Chick peas	ˈniχːiː					
Clean	nəˈðiːf					
Train	qəˈtˤaːr	ʁəˈtˤaːr				
Table	ˈtˤaːulə					
Ice cream	ˈbərːəd	ˈbʌriːd				

Note. B= Bedouin.

Table 2.3 presents the trisyllabic and 4-syllable words. The dialect issue is manifested here in the word “balloon”; the two variants occur in the Bedouin dialect only.

Table 2.3 Multisyllabic words in the study list with variants

Multisyllabic		Variants	
Sink	məʁˈsələ	məqˈsələ	
Washing machine	ʁəˈsaːlə	qəˈsaːlə	
Three	θəˈlæːθə		
Arabic Dress for men	dɪʃˈdaːʃə		
An Apple	təˈfaħə	təˈfaħ (Pl.)	
Red Beans	ˌbaːˈdʒɪlːə		

Table 2.3 (cont.)

Multisyllabic	Variants		
Soap bar	sˤaˈbuːnə	sˤaˈbuːn (Pl.)	
A fly	ðəˈbːaːnə		
An Air Plane	tˤəˈjːaːrə		
A hammer	maˈtˤrɪgə		
School	məˈdrɪsə		
A triangle	muˈθəlːəθ		
Long Underpants	ʔəmˈkʰsər	mˌˈkʰsːər	
A Balloon	təfaˈχiːjə	təfeːˈχə (B)	tʌfaːˈχəʰ (B)
An orange	ˌbərtəˈqalə	ˌbərtəˈʁalə	ˌbərtəˈqalᵇ (Pl.)

Note. B = Bedouin dialect

In summary, many of these words had more than one acceptable variant (see Tables 2.1-2.3), namely, 15 out of the 23 monosyllabic words had one or more acceptable variant. The disyllabic words had 19 with acceptable variants out of a total of 50. The 13 trisyllabic words had six with acceptable variants. For the four-syllable words (two words only), one had one acceptable variant and the other had two.

These acceptable variants varied in relation to vowel epenthesis, vowel deletion, glottal stop and central vowel epenthesis or addition, and vowel place change. Some variants were in the form of stopping of uvular fricatives, and others were in the form of frication of a uvular stop. In addition, many of them involved morphological issues such as the production of the plural variant instead of the singular or the other way round or influence of the phonology of the singular form on the plural, or vice versa. Another variation was the gender issue because Arabic has a male-female distinction. Only a few words were omitted from the analysis because they were produced in standard Arabic rather than the spoken dialect. These variants change the numbers for adult targets as reported in Table 2.4; however they were taken into account in the results.

The following tables (2.4-2.9) made use of CAPES (Masterson and Bernhardt, 2001) and show a comprehensive adult Kuwaiti Arabic profile based on the elicitation word list. These are for the most common variant of each word. In the word shape Table 2.4, each word is represented in a consonant-vowel shape with the percentage of its occurrence within the word list. The most frequent word shape for monosyllabic words was CVC (10.2%); the least frequent was CVV (1.1%). For disyllabic words, CVCVC was most frequent (26.1%), and CVVCV least frequent (1.1%). For multisyllabic word lengths, the most frequent word shape was the CVCVCV (8.0%); others were minimally represented.

Table 2.4 Arabic word shapes in word list, by number of syllables

Word shapes					
1-syl		2-syl		Multisyl	
CVV	1.1%	**CVCV**	12.5%	**CVCVCV**	8.0%
CVC	10.2%	CV.VC	1.1%	CVCCVCV	4.5%
CCVC	8.0%	CCVCV	1.1%	CVCVCVC	1.1%
CVCC	6.8%	CVCCV	5.7%	CVCCVCVC	1.1%
		CVVCV	1.1%	CVCVCVCV	1.1%
		CVCVC	26.1%	CVCCVCVCV	1.1%
		CVCCVC	9.1%		

Note. Most frequent word shapes are bolded.

Stress patterns in the word list follow (percentages of words with two or more syllables).

Table 2.5 Stress patterns in the word list

Stress Pattern	Total%
Strong-weak	58.46%
weak-Strong	18.46%
weak-Strong-weak	18.46%
secondary-Strong-weak	1.50%
secondary-weak-Strong-weak	1.50%
weak-weak-Strong-weak	1.50%

Note. It is not clear that there is secondary stress as in
English but there appears to be some sress on those initial syllables.
Monosyllabic words are not included.

The Strong-weak pattern was the most frequent (58.46%), and the least frequent were the Secondary-Strong-weak (1.50%) and the four-syllable words of Secondary-weak-Strong-weak, and weak-weak-Strong-weak with 1.50% for each.

The tables below (Tables 2.6–2.8) show a sample of the consonant sequences of adult Arabic for monosyllabic, disyllabic, and multisyllabic words across word positions. These tables also identify the Place and the Manner features for these consonant sequences.

Table 2.6 Consonant clusters in monosyllabic words

First C	Adult	Place	Manner	WI	WF
Stops	bj	L-C	S-G	1	
Fricatives	fl	L-C	F-L	1	
	sr	C-C	F-L	1	
	sˤħ	C-P	F-F	1	
	χʃ	D-C	F-F	1	
	χj	D-C	F-G	1	
Affricates	dʒd	C-C	Aff-S	1	
Nasals	nt	C-C	N-S		1
Liquids	rd	C-C	L-S		1
	lb	C-L	L-S		1
	ldʒ	C-C	L-Aff		1
	ltʃ	C-C	L-Aff		1
Glides	jl	C-C	G-L		1

Note: L= Labial, C=Coronal, P= Pharyngeal, D= Dorsal Manner: S= Stop, G= Glottal, N= Nasal, F= Fricative, L= Lateral, Aff= Affricate.

Table 2.7 Consonant clusters in disyllabic words

First C	Adult	Place	Manner	WI	WM	WF
Stops	dl	C-C	S-L		1	
Nasals	nt$^{\varsigma}$	C-C	N-S		1	
	ŋg	D-D	N-S		1	
Fricatives	ft	L-C	F-S		1	
	fʃ	L-C	F-F		1	
	sm	C-L	F-N	1		
	sn	C-C	F-N		1	
	ʕt	P-C	F-S		1	
Affricates	tʃb	C-L	Aff-S		1	
Liquids	rn	C-C	L-N		1	
	rs	C-C	L-F		1	
Glides	wð	L-C	G-F		1	
	jn	C-C	G-N		1	
	jk	C-D	G-D		1	

Note: L= Labial, C=Coronal, P= Pharyngeal, D= Dorsal.
Manner: S= Stop, G= Glottal, N= Nasal, F= Fricative, L= Lateral, Aff= Affricate.

Table 2.8 Consonant clusters in multisyllabic words

First C	Adult	Place	Manner	WI	WM	WF
Stops	dr	C-C	S-L		1	
	t$^{\varsigma}$r	C-C	S-L		1	
Nasals	mk^{h}	L-D	N-S		1	
Fricatives	ʃd	C-D	F-S		1	
	ʁs	D-C	F-F		1	
Liquids	rt	C-C	L-S		1	

Note: L= Labial, C=Coronal, P= Pharyngeal, D= Dorsal.
Manner: S= Stop, G= Glottal, N= Nasal, F= Fricative, L= Lateral, Aff= Affricate.

The Kuwaiti Arabic consonant inventory is shown in Tables 2.9 and 2.10. Table 2.9 shows segments by word position and length, and Table 2.10 summarizes across word lengths.

Table 2.9 Arabic consonant inventory

			1-syl			2-syl				Multisyllabic			
			WI	WF	Sum	WI	WM	WF	Sum	WI	WM	WF	Sum
Stops	Labial	b	4	0	4	3	3	3	9	2	1	0	3
		bː								0	1	0	1
	Coronal	t	0	2	2	1	0	1	2	2	0	0	2
		d	0	1	1	2	1	2	5	1	0	0	1
		tˤ	0	2	2	1	1	1	3	1	0	0	1
		tːˤʰ	0	1	1	0	1	0	1	0	0	0	
	Dorsal	k	0	0		2	1	0	3	0	0	0	
		g	0	1	1	2	0	0	2	0	1	0	1
		q	0	0		2	0	0	2	0	1	0	1
		qː	0	0		0	1	0	1	0	0	0	
	Glottal	ʔ	1	0	1	4	0	0	4	1	0	0	1
Nasals	Labial	m	0	2	2	6	1	1	8	4	0	0	4
	Coronal	n	0	1	1	2	0	3	5	0	2	0	2
Fricatives	Labial	f	2	0	2	0	0	3	3	0	2	0	2
	Coronal	s	0	1	1	2	1	2	5	0	3	0	3
		sˤ	0	0		2	1	1	4	1	0	0	1
		sːˤ	0	0		0	2	0	2	0	0	0	
		ð	0	0		0	2	0	2	1	0	0	1
		ðˤ	0	0		0	1	0		0	0	0	
		θ	0	0		0	0	0		1	2	1	4
		z	0	0		1	2	1	4	0	0	0	
		ʃ	0	0		1	2	0	3	0	1	0	1
	Dorsal	χ	2	0	2	3	1	1	5	0	1	0	1
		ʁ	0	0		0	0	1	1	1	0	0	1
	Pharyngeal	ʕ	1	0	1	1	2	1	4	0	0	0	
		ħ	1	1	2	2	2	1	5	0	1	0	1
	Glottal	h	0	0		2	0	0	2	0	0	0	
Affricates	Coronal	ʧ	2	0	2	0	1	1	2	0	0	0	
		ʤ	0	0	0	4	1	0	5	0	1	0	1
Liquids	Trill	r	1	2	3	2	3	6	11	0	1	1	1
		rː				0	1	0	1				
	Lateral	l	2	2	4	1	4	3	8	0	5	0	5
Glides	Labial	w	0	0		2	2	0	4				
	Coronal	j	0	0		1	0	0	1	0	1	0	1
		jː	0	0		0	0	0		0	1	0	1

Note. Numbers equal tokens for Kuwaiti Arabic word list for elicitation.

Table 2.10 Overall singleton tokens

Manner	Place		Overall			
			WI	WM	WF	Sum
Stops	Labial	b	9	4	3	16
		bː	0	1	0	1
	Coronal	t	3	0	3	6
		d	3	1	3	7
		tˤ	2	1	3	6
		tːˤʰ	0	1	1	2
	Dorsal	k	2	1	0	3
		g	2	1	1	4
		q	2	1	0	3
		qː	0	1	0	1
	Glottal	ʔ	6	0	0	6
Nasals	Labial	m	10	1	3	14
	Coronal	n	2	2	4	8
Fricatives	Labial	f	2	2	3	7
		s	2	4	3	9
	Coronal	sˤ	3	1	1	5
		sːˤ	0	2	0	2
		ð	1	2	0	3
		ðˤ	0	1	0	1
		θ	1	2	1	4
		z	1	2	1	4
		ʃ	1	3	0	4
		χ	5	2	1	8
	Dorsal	ʁ	1	0	1	2
		ʕ	2	2	1	5
	Pharyngeal	ħ	3	3	2	8
	Glottal	h	2	0	0	2
Affricates	Coronal	tʃ	2	1	1	4
		dʒ	4	2	0	6
Liquids	Trill	r	3	4	9	**15**
		rː	0	1	0	1
	Lateral	l	4	9	5	**17**
Glides	Labial	w	2	2	0	4
	Coronal	j	1	1	0	2
		jː	0	1	0	1

Overall an attempt was made to obtain two minimum productions of each target. The most frequent phonemes were the lateral /l/ (17 tokens), the labial stop /b/ (16), the /r/ (15), the labial nasal /m/ (14) and the coronal fricative /s/ (9). Least frequent were the long consonants /bː, qː, rː, jː/ and the fricative /ðˤ/ (once each).

Table 2.11 shows the vowels targeted in the word list (not evaluated in the current thesis).The labels 'WI', 'WM', and "WF" refer to the syllable the vowel is in; "WI" vowels are always preceded by an onset consonant; "WF" vowels may be followed by a coda.

Table 2.11 Arabic vowels in the word list

Monosyllabic				Disyllabic				Multisyllabic			
Vowels	WI	WM	WF	Vowels	WI	WM	WF	Vowels	WI	WM	WF
i				i		2	3	i	0	0	
iː		4		iː		2	0	iː	0	1	
ɪ		1		ɪ		9	0	ɪ	0	4	
e		1		e		2	0	e	0	0	
eː		2		eː		0	0	eː	0	0	
ɛ		2		ɛ		2	0	ɛ	0	0	
æː				æː		1	0	æː	0	1	
ə		2		ə		27	10	ə	0	16	13
a		1		a		18	3	a	0	5	
aː				aː		7	0	aː	0	5	
u				u		2	1	u	0	1	
uː		6		uː		4	1	uː	0	1	
ʌ		1		ʌ		2	0	ʌ	0	0	
oː		2		oː		1	0	oː	0	0	
au				au		1	0	au	0	0	
iu				iu		1	0	iu	0	0	
ai			1	ai		0	0	ai	0	0	

2.5 Transcription Including Reliability

Transcription was done for the adult data set by the author, with data entered into Excel spreadsheets. Transcription training and reliability was done by two committee members and the author. Ten percent of the words were re-transcribed across a random selection of participants. That procedure ensured the coverage of all features and structures. Transcription reliability was 95% with the two additional transcribers. The language bias factor affected perception of some sounds for me as a native speaker of Arabic; for example, hearing the epenthetic /ə/ in a consonant sequence was not easy for me at first, nor was slight devoicing; consultation with committee members was therefore important for transcribing some children who had unusual productions. Special software (AVS Audio Editor, Online Media Techonologies, Ltd, 2009) subscription was purchased from the website in order to facilitate listening procedures by viewing the wave forms to maintain accuracy. Procedures followed those described in Bernhardt and Stemberger (in press) for external reliability. Five samples were sent to a laboratory in the United States to someone familiar with Arabic transcription; the independent lab revealed average reliability of 87.15% with the author's transcriptions for consonants, varying by sample between 81.96% and 90.83%. Reliability was considered only for consonants for this thesis; vowels were deferred for future studies.

2.6 Analysis

All 80 samples were transcribed on Excel sheets by the author (the only local Kuwaiti Arabic speaker familiar with transcription) over the course of 11 months (delays were because of an extended medical leave). Using Excel sheets, a phonological analysis was quantified manually for the whole sample. I developed a color-coding system to categorize

and sort out the changes in the segments. For example, lavender was for the acceptable variants, yellow for vowel mismatches. Some colors were used to represent more than one feature at a time. Whole-word match was calculated by a research assistant in the phonology lab in the School of Audiology and Speech Sciences. By Whole Word Match is meant that the child's production of the word must fully match the adult target, including slight degrooving of sibilants. All errors were counted on the level of the individual phoneme. For the word shape analysis, based on numbers of participants, both independent and relational analyses were conducted. Details on analyses are mentioned in each sub-section under Results. Consonant inventory acquisition was quantified by finding the percentage of acquired segments by age group and across participants. Data were divided by proportion of children for each consonant, following the literature, on levels of acquisition, i.e., mastery, customary production, or unacquired (Stoel-Gammon and Dunn, 1985).

(1) 90% or more children had no or at most one-two mismatches for this consonant.

(2) 75%-89% of children had no or at most one-two mismatches for this consonant

(3) less than 75% of the children had acquired this consonant (no or at most one-two mismatches).

Note that accuracy was calculated within child and across groups.

Phonological feature mismatches for single consonants (token analysis) were analyzed for the three categories: Manner, Laryngeal, and Place. Finally the consonant clusters for all the groups were analyzed by word-initial, word- medial and word-final positions. To ensure reliability of hand counts, a second pass was made through the data with errors corrected.

A number of *t*-tests were employed to investigate statistical significance using PASW (2010) comparing the younger and the older age groups in terms of Manner, Laryngeal, and Place feature mismatches, and word shapes (at-risk group omitted).

3 RESULTS

This chapter explores the findings of the current study. Analyses are presented in the following order: (1) word elicitation issues; (2) whole-word match (defined below); (3) word structure inventory and matches; (4) consonant inventory development, to determine which speech sounds have and have not been acquired by 75% and 90% of the 4-year-olds; (5) consonant feature mismatch patterns; and (6) cluster mismatch patterns. Throughout, acceptable variants across children are noted. The results are presented for three participating groups: a younger age group, an older age group and a group of eight children at possible risk for protracted phonological development (see methods for ages).

3.1 Word Elicitation Issues

During picture elicitation, it was clear that some target words were difficult to elicit for dialectal or morphological reasons. Words that many children did not seem to know were: /maˈsˁːəsˁ/ (*straw*), /ʔəmˈkʰsər/ (*Arabic long underpants*) and occasionally others, e.g., /beˈʕiːr/ (*camel*, because they used the standard /ˈdʒəməl/), /qəˈtˁaːr/ (*train*). Regarding morphology, the children tended to use the plural instead of the singular if it was simpler in phonological form (see examples below) or "over-generalized" the safe plural from standard Arabic. Arabic morphology (e.g., Boudelaa and Gaskell, 2000) shows suffixation of a whole syllable for the safe plural in most of the cases (e.g., feminine [ət]) vs. vowel epenthesis in the middle of words for the broken plural. The masculine broken plural, e.g., for the word 'house' /beːt/, has the plural form /bjuːt/, i.e., is "broken" by the epenthetic vowel/glide inserted in the middle of the root of the word; this pattern was over-generalized by the

children. An example of the feminine broken plural is the colloquial word /ˈgəfʃə/ with the broken plural form /gfaːʃ/. In contrast, the safe feminine plural for the word *lady* /səˈjidə/ is /səjiˈdəːt/. Words with over-generalized plural (acceptable) forms were as follows:

1. /ˈgfaːʃ/ (*spoons*) often produced as over-generalized safe plural [ˈgəfʃət], thus avoiding a consonant sequence in /ˈgfaːʃ/; this word was therefore omitted from the word list early on in testing.
2. /bʌtːˤʰ/ (*ducks*) was sometimes produced with the safe plural form [bʌtːˤʰət].
3. /dʒduːr/ (*pots*) was produced by some children as safe plural [dʒɪdrat], avoiding a consonant sequence in /dʒduːr/.
4. /χʃuːm/ (*noses*) was produced with the safe feminine plural [ˈχəʃmət] by some children, again avoiding a consonant sequence in /χʃuːm/.
5. Children also used plural instead of singular with deletion of the word- final [ə] in the words below, shortening the words

صابونه	/sˤaˈbuːnə/	[sˤaˈbuːnː]	*bar of soap*
برتقالة	/ˌbərtəˈqalə/	[ˌbərtəˈqal]	*orange* –Pl
موزة	/ˈmoːzə/	[ˈmoːz]	*banana*

In Kuwaiti Arabic conversation, when offering a child or someone oranges or bananas, we often use the plural form. That is possibly the reason for the children over-generalizing plural in some of the above cases.

6. A special case appeared to be the word *fish*, which has an initial cluster in the singular /ˈsmɪtʃə/ (unless a vowel is epenthesized before the first consonant as an acceptable variant) and no cluster in the plural /ˈsɪmətʃ/. Children would possibly choose the plural because it was simpler (CVCVC instead of CCVCV). Another infrequent variant was as follows:

سمك	/ˈsɪmətʃ/	[ˈsmuːtʃ]	*fish* (Pl)

In this case, the vowel /u:/ (often a vowel change in plurals) possibly over-generalized as did deletion of the final vowel, forming an unacceptable plural fusion between plural and singular.

The use of standard Arabic in the Kindergarten probably contributed to this issue, where the children were not sure which form to produce.

3.2 Whole-Word Match (WWM)

Whole-word match is a measure wherein each word spoken by a child is compared with the adult target, which it must match exactly, including slight degrooving of sibilants. (This measure is being used in a crosslinguistic study currently underway with which this study is affiliated [Bernhardt and Stemberger, 2010].) The mean WWM for all children was 80.7% (SD, 14.6%; range of 39.29%–98.85%). Looking first at the two age-based groups of the study, the younger age group (46-54 months) showed a WWM of 80.9% with a standard deviation of 14.9% (range 39.3-98.8%). The older age group (55-62 months) showed a WWM of 79.5% with a standard deviation of 14.1% (range 43-98.9%). Thus, the means and the standard deviations for the two age groups were equivalent. Thus, 4-year-old Kuwaiti Arabic preschoolers show a wide range of accurate phonological forms (see also Tables 3.1–

3.4), and consequently a high proportion of whole-word matches. A third group of eight children (five older and three younger) was classified post-hoc as possibly “at-risk” for protracted phonological development (see Tables 3.5–3.6) based on WWM; these children had a WWM lower than 57%, i.e., more than two standard deviations below the mean for their age group. The mean WWM for the at-risk group was 48.5% (SD 5.9%, range of 39.3-56.8%). The age range for the group was 49-57 months (mean 54 months, SD 3.9 months).

With the at-risk children removed from the other groups, the WWM shifted to a mean of 83.9% (SD 9.9%, range of 61.3-98.8%) for the younger and for the older, a mean of 82.6% (SD 10.9%, range of 59.8-98.9%). However, this older group had two children with WWM of 59.8% and 61.6%), and the younger, one child with a 61.3% WWM. These children could also have been considered at-risk, but they were at least three percentage points higher than the highest in the at-risk group and were just at the borderline of two standard deviations, and therefore they were included in their respective age groups. With these outliers removed, the WWM of the older group was 85.8% (SD 8.8%) and of the younger, 84.5% (SD 9.4%).

Children scoring at two standard deviations below the mean may require more evaluation in the future if they continue to show lags. Data were analysed for three groups (younger, older, and at-risk) throughout, in order to determine any between-group differences.

3.3 Word-Shape Analysis - Inventory and Relational Analysis

3.3.1 Word-Shape Acquisition—Younger Age Group

Table 3.1 displays the mismatches among word shapes according to word length, with numbers representing numbers of children. Each child was entered only once, even if they had more than one word showing such a pattern.

Table 3.1 Word shape patterns by number of children—younger age group (n=40)

	C del	Syl del		C epen	V epen		C > C:	C: > C	V > V:
		✓	X		✓	X			
CVV									
CVC				2		2			
CCVC	2			2	32				
CVCC						2	1		
CVCV	1		3			1		1	
CV.VC	1					13			
CCVCV	1				9				
CVCCV		1							
CVVCV	1								
CVCVC	4	1	7	5	18			1	2
CVCCVC	5		1				1		
CVCVCV	1		12			1		1	1
CVCCVCV	5	1							
CVCVCVC	1	1							
CVCCVCVC	6	2					5		
CVCVCVCV	1		8				3		
CVCCVCVCV	7	1	6	1					

Note: Occasionally consonant deletion plus vowel addition = CV metathesis, i.e. the consonant is deleted from its original location. ✓ = acceptable; X = unacceptable.
[a]Use of plural instead of singular or alternate acceptable variant.

Overall, word shape results were relatively strong, although there were mismatches across the word lengths and shapes for a few children. As expected for word shape mismatches, these included consonant and vowel deletions (with some syllable deletions) and consonant or vowel additions (epenthesis). Metathesis was seen on occasion.

The results for monosyllabic words will be presented first. The word shape CVV was 100% acquired for the younger age group.

The results showed two children (5%) with consonant and vowel epenthesis for the shape CVC:

خم /χəm/ [ʔjχəm] *to mop* (acceptable)

For the word shape CCVC, two children over-generalized an unacceptable type of safe plural [dʒruːdət] for /dʒduːr/, showing a type of metathesis (/r/, /d/) as a result:

جدور /dʒduːr/ [dʒruːdət] *pots* (Pl)

The metathesis above was not a true word shape mismatch, but it is still a mismatch in terms of word use and plural form.

For the same word shape (CCVC) 32/40 children had acceptable vowel epenthesis in clusters, either before the first consonant or between first two consonants.

Two children also showed vowel epenthesis for the word shape CVCC (avoiding the final cluster), and one child, consonant lengthening, as shown below:

برد /bərd/ [bərːəd] *cold*

In disyllabic words, mismatches for CVCV included one child with vowel epenthesis plus

a) one child with full syllable deletion (and thus both a consonant and vowel deletion)

دوا /ˈduwa/ [ˈdu] *medicine*

b) three children with final vowel deletions

موزة /ˈmoːzə/ [ˈmoːz] *banana* (acceptable)

c) and one child with consonant shortening.

نخي /ˈniχːiː/ [ˈniħiː] *chickpeas*

For the word shape CV.VC (the word /riˈuːl/), one child showed consonant deletion, and 13 children acceptable vowel epenthesis. This word had the largest number of variants in the word list (see Table 2.2). (Note that the example below was not acceptable in terms of consonant production.)

ريول /riˈuːl/ [ʔəɰˈuːl] *feet*

The frequently elicited disyllabic shape CVCVC (i.e., with a coda) had several patterns:

a) four children with consonant deletion (including syllable deletion) as in

بعير /beˈʕiːr/ [ˈʕiːr] *camel* (initial weak syllable deletion, IWSD)

خبز /ˈχəbəz/ [ˈobəz] *bread*

b) one child with only vowel deletion, and two children with deletion plus vowel lengthening as in

سمك /ˈsɪməʧ/ [ˈsmuːʧ] *fish* (Pl) (unacceptable but reflecting broken plural)

In the example above the child perhaps over-generalized the broken plural for the word *houses* where the /uː/ is a plural marker. The child production in the above example resembles the plural form of /bjuːt/.

c) five children with consonant epenthesis, or metathesis as in:

بعارين /beˈʕiːr/ (Sg) [bəˈʕæriːn] (Pl) *camel*

جبن /ˈʤɪbən/ (Pl) [ˈʤɪbnə] (Sg) *cheese* (metathesis)

In the example above, for the word *cheese*, the metathesis resembles the feminine singular form for nouns, like the word /sˁaˈbuːnə/. The child possibly used the singular form of the word *cheese*, as a possible over-generalization of the feminine singular form CV.

d) 18 children (45%) with vowel additions, (and sometimes metathesis) as in

برد /ˈbərːəd/ [ˈbəriːəd] *ice cream*

e) one child with consonant shortening (and long vowel addition) for CVC:VC as in

برد /ˈbərːəd/ [ˈbəriːəd] *ice cream*

f) and seven children with acceptable syllable deletions.

بعير / beˈʕiːr/ [ˈbʕiːr] *camel* (acceptable)

For disyllabic words with consonant sequences, a number of patterns were also seen. The word shape CCVCV, with a word-initial cluster, showed one child with consonant deletion (CV metathesis) and nine children with initial vowel addition, as in

سمكة /ˈsmɪtʃə/ [ˈsɪmtʃə] *fish* (Sg)

سمكة /ˈsmɪtʃə/ [ʔəˈsmɪtʃə] *fish* (Sg) (acceptable)

The plural of this word is [ˈsɪmətʃ], and CV metathesis may reflect influence of the C and V in the plural.

(C)VCCV with a medial sequence, showed:

a) one child with vowel deletion (and a phone that had a syllabic nasal quality, somewhat unreleased), as in

جنطة /ˈdʒəntˁə/ [ˈdʒnˈtˁə] *handbag*

b) and one child with consonant deletion (as part of syllable deletion).

روضة /ˈrawðˁə/ [ˈβːə] *kindergarten*

The more complex word shape CVCCVC, with both a word-medial sequence and a word-final coda, showed the following acquisition patterns:

a) five children with consonant deletion, as in the words

مفتاح /mɪfˈtaħ/ [ɪfˈtaːħ] *key*

أرنب /ˈʔərnəb/ [ˈʔənəb] *rabbit*

b) one child with initial weak syllable deletion, as in

أسنان /ʔaˈsnaːn/ [ˈsnaːn] *teeth* (IWSD)

c) and one child with consonant lengthening in a medial sequence.

مفتاح /mɪfˈtaħ/ [mɪfˈtːˤaħ] *key*

Among words three syllables in length, the CVCVCV word shape had

a) one child with initial vowel epenthesis, as in the word

غساله /ʁəˈsaːlə/ [əʁəˈsaːləʰ] *washing machine*

b) and 12 children with acceptable syllable deletion (creating plurals).

صابونة /sˤaˈbuːnə/ [sˤaˈbuːn] *bar of soap* (acceptable)

The word shape CVCCVCV demonstrated

a) five children with consonant deletions, in the medial sequence as in

دشداشة /dɪʃˈdaːʃə/ [dɪˈdaːʃə] *Arabic dress for men*

[dɪˈʃaːʃə]

b) and one child with vowel deletions in the medial sequence.

مدرسة /məˈdrɪsə/ [məˈdɾsə] *school*

The word shape CVCVCVC had one child showing both consonant and vowel deletion (IWSD):

مثلث /muˈθəlːəθ/ [ˈθəlːəθ] *triangle*

The complex word shape CVCCVCVC had

a) six children with consonant deletions, (and in some cases, IWSD) as in the following variable productions of the same word, i.e.,

مكسر /ʔəmˈkʰəsər/ [ˌmˈkʰːəsːər] *long underpants*

[ˈkʰəsːər]

[əmˈkʰəsːər]

b) two children with vowel deletions, as in the word above

c) and five children with consonant lengthening, as in the word above.

For the four-syllable words, the simple alternating word shape CVCVCVCV showed

a) one child with unacceptable consonant plus vowel (syllable) deletion, as in the word

تفاخية /təfaˈχiːjə/ [təˈfaχ] *balloon*

b) eight children with acceptable syllable deletion as in the word

تفاخية /təfaˈχiːjə/ [təf eːˈχə] *balloon* (acceptable)

c) and three children with medial consonant lengthening, as in the word above, which in their cases was produced as the following: [təfːaˈχiːjə].

The long and complex word shape CVCCVCVCV had

a) seven children with consonant deletions, as in the variable production of the singular word

برتقالة /ˌbərtəˈqalə/ [tɔˈqalə] *orange* (syllable deletion)

[ˌbətəˈqal] *orange* (Pl)

[pe̞θˈqalə] *orange* WSD

b) one child with vowel deletion, as in the variable production of the word above and the following:

برتقالة /ˌbərtəˈqalə/ [ˌbətˈqalə] *orange* (medial WSD)

c) one child with consonant epenthesis

d) and six children with acceptable syllable deletion as in the plural variable of the singular word:

برتقالة /ˌbərtəˈqalə/ [ˌbərtəˈqal] *orange* (Pl)

3.3.2 Word Shape Acquisition—Older Age Group

Table 3.2 shows word shape patterns for the older age group.

Table 3.2 Word shape patterns by number of children—older age group (n=32)

	C del	Syl del [a]		C epen	V epen (Acceptable)	C > C:	V > V:
		✓	X				
CVV							
CVC							
CCVC	1			3	20		
CVCC							
CVCV			3				1
CV.VC					17		
CCVCV					12		
CVCCV							
CVVCV							
CVCVC	1	2	7[a]				
CVCCVC	1		1[a]			1	
CVCVCV		1	9[a]				
CVCCVCV	1	1					
CVCVCVC	1	1					
CVCCVCVC	2	1					
CVCVCVCV			2[a]			1	
CVCCVCVCV	3		2[a]				

Note: Occasionally consonant deletion and vowel addition represent CV metathesis, as noted in the text.
[a]Acceptable plural instead of singular, or different variants of words.

The word shape results for the older age group show 100% acquisition (no mismatches) of CVV, CVC, and CVCC in monosyllabic words and of the following word shapes in disyllabic ones: CVCV, CVVCV, CCVCV and CVCCV. In the trisyllabic words, the CVCVCV word shape was acquired by 96 % of the children, while other trisyllabic word shapes showed two to three children with mismatches. Mismatches were also observed in the four-syllable words for two to three children.

For the CCVC word shape, there was:

a) one child with consonant deletion, as in the word

جدور /dʒduːr/ [duːr] *pots*

b) two children with acceptable consonant epenthesis, as in the word

سرير /sriːr/ [ʔəˈsriːr] *bed* (acceptable)

c) and 20/32 children (62.5%) with acceptable vowel epenthesis, as in the word

سرير /sriːr/ [səˈriːr] *bed* (acceptable)

For the disyllabic word shape CVCV:

a) one child demonstrated vowel lengthening/diphthongization, as in

حلو /ˈħɛlu/ [ˈħɛlou] *sweet/nice*

b) three children showed (acceptable) syllable deletion for the singular word as in

موزة /ˈmoːzə/ [ˈmoːz] *banana* (Pl) (acceptable)

For disyllabic words with clusters, a few minority patterns emerged. CVCCVC showed

a) one child with medial consonant deletion in a sequence, as in

أرنب /ˈʔərnəb/ [ˈʔənəb] *rabbit*

b) and one child with medial consonant lengthening as in

أرنب /ˈʔərnəb/ [ˈʔənːəb] *rabbit*

The trisyllabic word shape CVCVCVC showed one child with consonant and vowel (weak syllable) deletion, as in the example below:

مثلث /muˈθəlːəθ/ [ˈθəlːəθ] *triangle* (IWSD)

For CVCCVCV there was one child with consonant deletion in the cluster, as in

مدرسة /məˈdrɪsə/ [məˈdɪsə] *school*

For CVCCVCVC, two children showed consonant deletions and one child vowel deletion (weak syllable deletion), as in

مكسر /ʔəmˈkʰəsər/ [ˈkʰəsər] *long underpants* (IWSD)

For the four-syllable words, one child showed medial consonant lengthening for CVCVCVCV and three had consonant (and some vowel/syllable) deletions for CVCCVCVCV. For example, the words for *orange* and *balloon* were produced as follows:

تفاخية /təfaˈχiːjə/ [tifːaˈχiːjəʰ] *balloon*

برتقالة /ˌbərtəˈqalə/ [ˈqələ] *orange* (IWSD, twice)

Three children had acceptable syllable deletion for *orange*, producing the plural form where the final syllable was deleted; in addition, one was an unacceptable form as shown above. The other two acceptable syllable deletions for the word *balloon* (Bedouin dialect) were shown previously. More detail will be provided about the cluster sequence patterns later.

3.3.3 Word Shape Acquisition—At-Risk Group

Table 3.3 shows word shape patterns for the at-risk group.

Table 3.3 Word-shape acquisition by number of children—at-risk group

	C del	Syl del		C ✓ epen	V epen		C > C:	C: > C
		✓	X		✓	X		
CVV								
CVC								
CCVC	1			4	8			
CVCC								
CVC(:)V						1		2
CV.VC		1			3			
CCVCV								
CVCCV								
CVVCV								
CVCVC	2	3	2[a]		3			
CVCCVC	3		1[a]				1	
CVCVCV			1[b]					
CVCCVCV			1					
CVCVCVC								
CVCCVCVC	3	2	2					
CVCVCVCV							2	
CVCCVCVCV			1[b]					

Note. ✓ = acceptable; X = unacceptable.
[a]All had weak initial syllables.
[b]This child used the plural instead of singular (i.e., without final schwa).

The word shape results for this group of eight children reveal the following:

Monosyllabic word shapes CVV, CVC, and CVCC were 100% acquired. No mismatches were reported. For the word shape CCVC several patterns were seen:

a) one child with consonant (and vowel) addition, as in the word

صحون /sˤħuːn/ [ˈsˤʌnħuːn] *plates* (not acceptable)

b) all children with acceptable vowel epenthesis (100%), two as in the previous example but also the following words:

بيوت /bjuːt/ [ˈbejuːt] *houses*

فلوس /fluːs/ [efˈluːs] *money*

صحون /sˤħuːn/ [ˈsˤɔħuːn] *plates*

c) and four children with acceptable consonant epenthesis as in the word

صحون /sˤħuːn/ [ʔəsˤħuːn] *plates*

For two-syllable word shapes, CVVCV, CCVCV, CVCCV were 100% acquired without any mismatches reported. The word shape CVC(:)V showed

a) one child with vowel addition (and lengthening), as in the word

نخى /ˈniχːiː/ [ˈniːχiiː] *chickpeas*

b) and two children with consonant shortening.

قصة /ˈqəsˤːə/ (CVC:V) [ˈqəsˤə] *story*

The word shape CV.VC showed

a) one child with vowel deletion, as in the word

ريول /riˈuːl/ [ɖˈuːl] *feet*

b) and three children with acceptable vowel epenthesis (37.5%).

ريول /riˈuːl/ [ʔəliˈuːl] *feet*

The disyllabic word shape CVCVC (with coda) showed

a) two children with consonant (and vowel, i.e., weak syllable) deletion, as in

حجاب /ħaˈdʒaːb/ [ˈdʒaːb] *hair scarf* (IWSD)

نظيف /nəˈðiːf/ [ˈðiːf] *clean* (IWSD)

b) and three children with acceptable vowel epenthesis (37.5%).

حجاب /ħaˈdʒaːb/ [ʔəħaˈdʒaːb] *hair scarf*

The word shape CVCCVC had

a) three children with consonant deletions in the medial cluster; as in the word

أرنب /ˈʔərnəb/ [ˈʔənəb] *rabbit*

b) and one child with consonant lengthening in the medial cluster.

أرنب /ˈʔərnəb/ [ˈʔərnːəb] *rabbit*

Trisyllabic word shapes CVCVCV, CVCCVCV, and CVCVCVC were 100% acquired without any mismatches except acceptable use of plural instead of singular (syllable deletion). The word shape CVCCVCVC had:

a) three children with consonant deletions, as in the variable productions of the word

مكسـَّر /ʔəmˈkʰəsər/ [ˈkʰəsər] *long underpants* (IWSD)

[ˈkʰəsəl] (ISWD)

[ʔəmˈkʰəsə] (coda deletion)

b) and two children with vowel/syllable deletion, as in the previous examples.

The four-syllable word shape CVCCVCVCV was 100% acquired without any mismatches (one acceptable use of plural instead of singular). The word shape CVCVCVCV had two/eight children with consonant lengthening:

تفاخية /təfaˈχiːjə/ [təfːaˈχiːjə] *a balloon*

3.3.4 Summary Concerning Word Shapes

Table 3.4 shows a summary of the word shape acquisition. Because CVCVC is no longer CCVC when there is acceptable epenthesis, CCVC and CCVCV are omitted from the summary table because the target was not CCVC.

Table 3.4 Summary of word shape acquisition by proportion of children

Word length	Group	Acquired by 90+%	Acquired by 75-89%	Acquired by < 75%
1-syl	Younger	CVV CVC(C)		
	Older			
	At-risk			
2-syl	Younger	CV(V)CV CVCCV	CVCCVC CCVCV	CVCVC CV.VC
	Older	CV(V)CV CVCCV CVCCVC	CVCVC	CV.VC
	At-risk	CV(V)CV CVCCV	CVCCVC	CV.VC
Multisyllabic	Younger	CVCVCV(C)	CVC(C)(V)CVCV	CVCCVCVC
	Older	All multisyllabic except>	CVCCVCVC	CVCVCV
	At-risk	All multisyllabic except>	CVCVCVCV CVCCVCVC	

Note. All disyllabic and multisyllabic = the shapes probed in the sample. CCVC(V) are not included in the table because many children used the acceptable variants with vowel epenthesis.

The following monosyllabic word shapes were acquired by 90+% of all children: CVV, CVC, CVCC. Thus, codas, diphthongs and final clusters were acquired, but initial clusters were still developing, reflecting a high-ranked constraint on complexity. Overall, 90+% of the children had acquired most disyllabic word shapes; across groups, the following disyllabic word shapes were acquired by 90+% of the children: CVCV, CVVCV, CVCCV. Most multisyllabic word shapes were acquired by 90+% of the children in both the older and the at-risk groups, but the younger age group were still acquiring multisyllabic words with the shapes CVCVCV, CVCCVCVC, CVCVCVCV, and CVCCVCVCV.

An additional analysis examined potential interaction of stress and deletion in word-initial position. There were 11 instances in the younger age group of initial consonant deletion (in all but one cases, syllable deletion) in the unstressed syllable and none in the stressed syllable, i.e., .28 per child. The older age group had six tokens of initial consonant deletion (in syllable deletions), or .19 per child, the least of any group. For the at-risk group, there were five deletions for eight children, i.e., .63 per child. The difference between the age groups was not significant in a *t*-test (p = .058) probably because of the low numbers.

All children showed the same types of patterns but the older group showed fewer of them. The eight children in the at-risk group showed relative strength in word structure and similar patterns to the other age groups. A set of paired *t*-tests by word shape for the younger versus older groups (without the at-risk children) showed that all deletions by word shape except for acceptable syllable deletion were significantly fewer in the older group (*p* levels ranging from .001 for consonant deletion to .003 for all deletion of vowels and consonants, both acceptable and unacceptable). However, epenthesis of consonants and vowels was not significantly different for the groups, either for acceptable or unacceptable forms, even though the older children showed a lower mean number of such patterns (for acceptable epenthesis: younger, mean = 3.47, SD 8.75 per word shape; for older mean = 2.88, SD 6.57; for unacceptable epenthesis: younger mean = 1.12, SD 3.14. older, 0).

3.4 Consonant Inventory Acquisition

This section will introduce the consonant acquisition results by number of children. It will review the percentages of children who have acquired each segment by age groups and across word positions. The younger age group shall be discussed first, the older age group next, and finally the at-risk group.

3.4.1 Consonant Acquisition—Younger Age Group

Table 3.5 shows the proportion of children who had acquired various consonants (no mismatches), plus consonant mismatches by number of children for the younger age group. In this table, 90+% of children is represented by 0-4 children with no mismatches; 75-89% of the children is represented by 5-10 children with no mismatches. Otherwise, the segment was not considered acquired (less than 75% of children with no mismatches).

Table 3.5 Consonant matches and mismatches – younger age group

			% of children with no mismatches			Number of children with mismatches							
						1-syllable		2-syllable			Multisyllabic		
			90+	75-89	<75	WI	WF	WI	WM	WF	WI	WM	WF
Stops	Labial	b	✓			0		1	1	0	2	0	
		bː	✓									0	
	Coronal	t	✓				0	0		0	3		
		d	✓				0	1	0	0	1		
		tˤ		✓			3	0	0	1	1		
		tːˤʰ	✓				3		0				
	Dorsal	k	✓					1	0				
		g	✓				1	0				0	
		q		✓				5				3	
		qː	✓						3				
	Glottal	ʔ	✓			0		0			1		
Nasals	Labial	m	✓				0	2	0	0	0		
	Coronal	n	✓				0	1		1		0	
Fricatives	Labial	f	✓			0			1	0		0	
	Coronal	s			✓	4	2	6	8	2		4	
		sˤ			✓			4	4	4	4		
		sːˤ		✓					7				
		θ			✓						4	5	5
		ð		✓					2		7		
		ðˤ	✓						1				
		z			✓			10	3	4			
	Coronal	ʃ		✓				3	4			1	
		χ		✓		2		2	1	1		2	
		χː	✓						1				
	Dorsal	ʁ		✓						2	7		
		ʕ		✓		2		0	3	2			
	Pharyngeal	ħ	✓			0	0	0	1				
	Glottal	h	✓					0					
Affricates	Coronal	ʧ	✓			1			1	1			
		dʒ			✓			11	3			3	
Liquids	Trill	r			✓	4	6	6	8	9		6	4
		rː	✓						4				
	Lateral	l		✓		2	5	0	0	0		1	
Glides	Labial	w	✓					0	0			0	
	Coronal	j	✓					0				0	

In this age group, 90+% of the children had acquired stops across all places of articulation (labial, coronal, dorsal and glottal) except for the dorsal stop /q/ and coronal /tˤ/. Both of these segments were acquired by only 75%-89% of the children in word-initial position in disyllabic words. On the other hand, /q/ was acquired by 90+% of the children in word-medial position in multisyllabic words. The labial and coronal nasals /m/ and /n/ and glides /w/ and /j/ were acquired by 90+% of the children as were liquid /r:/, fricatives /f/, /ðˤ/, /χ:/, /h/ and /ħ/ plus affricate /tʃ/.

Other fricatives and liquids were more variable.

1. Over all positions, /s/ was acquired by less than 75% of the children. However, /s/ was acquired in monosyllabic words by 90+% of the children in both word-initial and final positions and in word-final position in the disyllabic words. For the multisyllabic words, /s/ was acquired by 90+% of the children in word-medial position. However, fewer than 75% of the children had acquired /s/ in the word-initial and medial positions of disyllabic words.
2. Overall, the emphatic coronal fricative /sˤ/ was acquired by less than75% of the children. It was, however, acquired by 90+% of the children across all positions in disyllabic words, and word initially in multisyllabic words.
3. The long emphatic coronal fricative /sːˤ/ was acquired by 75%-89% of the children in word-medial position in disyllabic words.

4. Taken as a whole, /ð/ was acquired by 75%-89% of this younger age group and /θ/ by less than 75% of the children. The /θ/ was observed in 75-89% of children in word-medial and -final positions in the multisyllabic words, although it was acquired by 90+% of the children in the initial position at the same word length. It was acquired by 90+% of the children across positions in both monosyllabic and disyllabic words. Similarly, the voiced coronal fricative /ð/ was acquired by 75%-89% of the children word-initially in the multisyllabic words and by 90+% word medially in the disyllabic words.
5. The overall findings indicate that /z/ was not acquired. The voiced coronal grooved fricative /z/ was acquired by 75%-89% of the children in the word-initial position at the disyllabic word length and by 90+% of the children in the word-medial and word-final positions for the same word length.
6. In spite of the findings below, /ʃ/ was acquired overall by only 75%-89% of the children. This [-anterior] coronal fricative /ʃ/ was acquired by 90+% of the children in word-initial and -medial positions in disyllabic words and in the word-medial position in multisyllabic words.
7. The dorsal fricative /χ/ and /ʁ/ were acquired generally by 75%-89% of the children in this age group. Conversely, /χ/ was acquired by 90+% of the children in the word-initial position at the monosyllabic word lengths, across word position in disyllabic words, and in the word-medial position in multisyllabic

words. The dorsal fricative /ʁ/ was acquired by 90+% of the children in the word-final position at the disyllabic word length, and by 75%-89% of the children in word-initial position at the multisyllabic length.

8. The pharyngeal fricatives /ʕ/, /ħ/ and /h/ were acquired by 90+% of the children in the word-initial position at the monosyllabic length. They were similarly acquired for the word-medial and -final positions in the disyllabic word length. Overall, however, /ʕ/ had been acquired by 75%-89% of the children.

9. The coronal affricate /dʒ/ was acquired overall by less than 75% of the children. However, it was acquired by 90+% of the children at both disyllabic and multisyllabic word lengths in the word-medial position. In general, 74% or fewer had acquired this segment in the word-initial position at the disyllabic word length.

10. In total, the trilled /r/ was not acquired by this age group. It was acquired by 90+% of the children in the word-initial position for the monosyllabic word length, and in the word-final position for the multisyllabic word length. Otherwise, 75%-89% of the children had acquired the same segment.

11. The lateral liquid /l/ was acquired by 90+% of the children across positions and word lengths, except for the word-final position in the monosyllabic word length, where it was acquired by 75%-89% of the children (bringing the overall level to 75-89%).

In summary, the following segments were acquired by 90+% or more of the children across word positions: stops /b, bː, t, tːˤ, d, k, g, qː, ʔ/, nasals /m, n/, fricatives and affricate,

/ðˤ, ħ, h, χː, tʃ/, liquid /rː/, and glides /w, j/. The following consonants were acquired by 75%-89% of the children across word positions: stops /tˤ, q/, fricatives, /sːˤ, ð, ʃ, ʁ, χ, ʕ/ and lateral /l/. The following consonants were not yet acquired across word positions to a 75% level: fricatives /s/, / sˤ/, /θ/, /z/, voiced affricate /dʒ/, and trilled /r/. Features not acquired were thus: Coronal [+grooved], [-grooved], [-cont]-[+cont] (affricate), [+trilled]. [Pharyngeal], [Dorsal,-high,-low] (uvulars) and [+lateral] were acquired to a level of 75-89%.

3.4.2 Consonant Acquisition—Older Age Group

Table 3.6 below shows the proportion of children who had acquired various consonants, plus consonant mismatches by number of children for the older age group. For this group, 0-3 = 90%, 4-8 = 75-89% and 9 or more = unacquired. The results for the consonantal inventory acquisition of the older age group show that 90+% of the children had acquired all stops and nasals across word positions and lengths. The following fricatives and affricate were acquired by 90+% of the children across all positions and at all word lengths: labiodental fricative /f/, the emphatic coronal fricative /ðˤ/, the coronal fricative /ʃ/ and affricate /tʃ/, the dorsal fricatives /χ/, /χː/ and /ʁ/, the pharyngeal fricative /ħ/, and the glottal fricative /h/. All liquids and glides were acquired except for /r/.

Table 3.6 Consonant matches and mismatches—older age group

			% of children with no mismatches			Number of children with mismatches							
						1-syl		2-syl			Multisyl		
			90+	75-89	<75	WI	WF	WI	WM	WF	WI	WM	WF
Stops	Labial	b	✓			0		0	0	1	2	0	
		bː	✓									0	
	Coronal	t	✓				0	0		0	1		
		d	✓				0	0	0	1	0		
		tˤ	✓				2	1	0	0	0		
		tːˤʰ	✓				0		0				
	Dorsal	k	✓					0	0				
		g	✓				0	0				0	
		q	✓					0					
		qː	✓						0				
	Glottal	ʔ	✓			0		1			0		
Nasals	Labial	m	✓				0	1	0	1	0		
	Coronal	n	✓				0	0		0		0	
Fricatives	Labial	f	✓			0			1	0		0	
		s			✓	1	5	9	9	11		9	
	Coronal	sˤ			✓	1		8	6	11	7		
		sːˤ			✓			2	8			1	
		θ		✓							1	3	3
		ð		✓					0		7		
		ðˤ	✓						1				
		z			✓			8	13	7			
		ʃ	✓					1	1	0		1	
		χ	✓			0		0	1	1		0	
		χː											
	Dorsal	ʁ	✓				1			1	0		
		ʕ		✓		0		3	1	1			
	Pharyngeal	ħ	✓			0	0	0	0				
	Glottal	h	✓			0		0					
Affricates	Coronal	ʧ	✓			2	0	1	0	0			
		dʒ		✓		0	0	7	1			2	
Liquids	Trill	r			✓	1	1	2	3	3		3	3
		rː	✓						1				
	Lateral	l	✓			1	2	0	0	0		1	
Glides	Labial	w	✓					0	0	0		0	
	Coronal	j(ː)	✓					0		0		0(0)	

Other fricatives, the affricate /dʒ/ and /r/ were less well-established.

1. As a whole, /s/ had not been acquired by this age group. It was acquired by 90+% of the children in the word-initial position at the monosyllabic word length, and by 75-89% of the children word finally in monosyllables. Elsewhere it was not acquired by 75% of children.
2. The overall results show that /sˤ/ and /sːˤ/ were not yet acquired. They were acquired by 90+% of the children at the word-initial position for the monosyllabic word length and for the long variant, medial position in multisyllabic words. Otherwise, there was variability from less than 75% to 75-89%.
3. The coronal fricative /θ/ was acquired by 90+% of the children at the multisyllabic word length across all positions, but overall were acquired by only 75%-89% of the children. The coronal fricative /ð/ was acquired by 90+% of the children at the word-medial position in disyllabic words, and by 75–89% of the children in the word-initial position at the multisyllabic word length. Thus, [-grooved] was ahead of [+grooved] in development.
4. The voiced coronal fricative /z/ was not acquired overall by this age group. However, it was acquired by 75%-89% of the children at the disyllabic word length in both word-initial and -final positions.
5. The pharyngeal fricative /ʕ/ was acquired by 90+% of the children at the disyllabic word length across all positions, and by 75%-89% of the children in all positions and word lengths.

6. Overall, /dʒ/ had been acquired by 75%-89% of the children across all word positions. It was acquired by 90+% of the children in both word-initial and word-final positions at the monosyllabic word length and in the word-medial position at the disyllabic word length. From 75%-89% of the children in the word-initial position had acquired /dʒ/ at the disyllabic word length, and 90+% of the children in the word-medial position at the multisyllabic word length.
7. The trilled liquid /r/ was not acquired overall by this older age group, although it was acquired by 90+% of the children at the monosyllabic word length both initially and finally (even though /rː/ was acquired). Results were similar to /r/-acquisition in di- and multisyllabic words; however, overall it did not meet the acquisition threshold.

In summary, the following segments were acquired by 90+% of the children across word positions: stops /b, bː, t, d, tˤ, tːˤʰ, k, g, q, qː, ʔ/, nasals /m, n/, fricatives and affricate /f, ðˤ, ʃ, χ, ʁ, ħ, h, tʃ/, liquids and glides /rː, l, w, j, jː/. The following consonants were acquired by 75%-89% of the children across word positions: /θ, ð, dʒ, ʕ/. This shows greater mastery by the older 4-year-olds compared with the younger age group for the same segments.The following consonants were not yet acquired across word positions by 75% of children: /s, sːˤ, r/. Features not yet acquired were Coronal [+ grooved] (and [Pharyngeal]) and [+trilled]. Coronal [-grooved] was developing as was the combination [-cont] [+cont] [+voiced] and [Pharyngeal][+cont].

3.4.3 Consonant Acquisition—At-Risk Group

Table 3.7 shows proportion of children acquiring various consonants, plus consonant mismatches by number of children for the at-risk age group. The table below allows one child out of eight (87.5%) to fail for feature mastery because a 90% criterion would be require all eight children to pass, a criterion higher than for the other groups.

The WWM results of this age group were one standard deviation below the mean for the entire group. Nonetheless, 87.5% to 90% (7-8 children) of this group had acquired the labial stop, dorsal, and glottal stops (plus qː) as well as labial and coronal nasals, and fricatives /f/, /χː/ and /h/, /l/ and glides /w/ and /j/. They showed less mastery of other categories.

Table 3.7 Consonant matches and mismatches—at-risk age group

			% of children with no mismatches			Number of children with mismatches							
						1-syl		2-syl			Multisyl		
			87.5	75-86	<75	WI	WF	WI	WM	WF	WI	WM	WF
Stops	Labial	b	✓			0		0	0	1	0	0	
		bː	✓									0	
	Coronal	t		✓			1	0		0	1		
		d		✓			0	0	0	1	1		
		tˤ			✓		1	1	2	1	2		
		tːˤʰ		✓			0		2				
	Dorsal	k	✓					1	0				
		g	✓				0	1				0	
		q			✓			3					
		qː	✓						0				
	Glottal	ʔ	✓			0		0			0		
Nasals	Labial	m	✓				0	0	0	0	0		
	Coronal	n	✓				0	0		0		0	
Fricatives	Labial	f	✓			0			0	0		0	
		s			✓	1	1	3	3	3		4	
	Coronal	sˤ			✓			4	1	3	2		

Table 3.7 (cont.)

			% of children with no mismatches			Number of children with mismatches							
						1-syl		2-syl			Multisyl		
			87.5	75-86	<75	WI	WF	WI	WM	WF	WI	WM	WF
Fricatives	Coronal	sːˤ			✓				3				
		θ			✓						1	2	1
		ð			✓				2	1	6		
		ðˤ		✓					2				
		z			✓			5	2	1			
		ʃ			✓			5	6			4	
		χ			✓	1		1	0	0		1	
		χː	✓						1				
	Dorsal	ʁ			✓					1	2		
		ʕ			✓	2		2	0	0			
	Pharyngeal	ħ			✓	2	0	1	0				
	Glottal	h	✓					1					
Affricates	Coronal	ʧʃ			✓	5			1	3			
		dʒ			✓			8	5			1	
Liquids	Trill	r			✓	3	2	4	4	5		3	4
		rː			✓				3				
	Lateral	l	✓			0	0	0	0	0		1	
Glides	Labial	w	✓					0	0			0	
	Coronal	j	✓					0				0	
		jː	✓									0	

The non-acquired elements for this at-risk group included several categories. First, the alveolar stops showed mismatches for two of the eight children. Also, coronal emphatic stop /tˤ/ at the monosyllabic word length, showed 87.5% of the group with this sound in word-final position. The same was found for the word-initial and -final positions at the disyllabic word length. For the trisyllabic word length, 75% (6/8) of the children had acquired that emphatic sound in the word-initial position. Meanwhile, the same number of children had acquired it at the disyllabic word length word-medially. The overall findings indicate that this emphatic coronal stop was not yet acquired. The long aspirated emphatic stop /tːˤʰ/ was acquired at the monosyllabic word length by the entire group, whereas 75% of the children

had acquired it at the disyllabic words lengths in the word-medial position. Overall, it was acquired by 75% of the children across positions and lengths.

As previously mentioned, this group showed less mastery of fricatives; nonetheless, the labial fricative /f/ and glottal /h/ were acquired.

1. The overall findings for /s/ that it was not yet acquired by this group although was acquired by 87.5% of the children in both initial and medial positions at the monosyllabic word length. The disyllabic and multisyllabic word lengths revealed that this fricative was not yet acquired across all word positions.
2. Overall, this fricative was not acquired by 75% of the group. This emphatic coronal fricative /sˤ/ was not used by 50% (4/8) of the children at the disyllabic word length in the word-initial position, but was used by 87.5% word medially. In the word-final position, 62.5% (5/8) used /sˤ/. At the multisyllabic length, 75% of the children had acquired the sound word-initially.
3. The long emphatic /sːˤ/ was acquired by 62.5% (5/8) in the word-medial position at the disyllabic word length.
4. The fricative sound /θ/ was acquired by 87.5% of the children at the multisyllabic word length in word-initial and -final positions, and by 75% in medial position. In total it was acquired by 50% (4/8) of the children.
5. The overall results show that this group had not acquired the fricative /ð/. It was acquired by 75% of the children in the word-medial position at the disyllabic word length, and by 87.5% in the word-final position. For the multisyllabic

words the same sound was acquired by 25% (2/8) of this group in the word-initial position. In total, 62.5% of this group acquired this sound at the disyllabic word length. The emphatic counterpart of /ð/ was acquired by 75% of the children in the word-medial position at the disyllabic word length.

6. The voiced coronal fricative /z/ was acquired by only 37.5% (3/8) of this at-risk group, and appeared not to be used by 62.5% of the children in disyllabic words in the word-initial position. This sound was acquired by 75% in the word-medial position and by 87.5% in the word-final position. Overall, the sound was not acquired by this particular group except for the word-medial and -final positions.
7. The [-anterior] fricative /ʃ/ was not acquired by this group of children. At the disyllabic word length, it was used only by 37.5% of the group in the word-initial position, and by 25% of the children in the word-medial position. For the multisyllabic word length, it was acquired by 50% of the children in the word-medial position.
8. For uvular fricatives, the /χ/ was acquired by 87.5% of the children in the word-initial positions at both monosyllabic and disyllabic word lengths, and in the same way at the multisyllabic word length in the word-medial position. In total, it was acquired by 62% of the children across word positions.
9. The fricative /ʁ/ was acquired by 87.5% of the children at the disyllabic word length in the word-final position, and by 75% of the children in the word-initial position for multisyllabic word lengths. In all, it was acquired by 62.5% of the group.

10. The pharyngeal fricative /ʕ/ was acquired by 50% of the children of this group (word-initial position at both monosyllabic and disyllabic word lengths).
11. The pharyngeal fricative /ħ/ was acquired by 62.5% of the children in general, and by 75% of the children in the word-initial position at the monosyllabic word length. Moreover, it was acquired by 87.5% of the children at the word-initial position for the disyllabic word length.
12. The affricate /dʒ/ word initially at the disyllabic word length was not acquired by this group. In the word-medial position, at the same word length, it was acquired by 37.5% of the children only. Therefore in total it was not yet acquired.
13. The voiceless coronal affricate was observed as follows: 37.5% of the children had acquired /tʃ/ word initially at the monosyllabic word length. At the disyllabic word length, it was acquired by 87.5% in word-medial position and by 62.5% in word-final position. The overall results disclosed that this at-risk group had not acquired this affricate.
14. The trilled liquid /r/ was another major area of difficulty for this group (not yet acquired). The /r/ was acquired by 62.5% word-initially in monosyllabic words, and by 75% word-finally, yet overall it was acquired by only 37.5% for this word length. For the disyllabic word length, /r/ was acquired by 50% of the children in the word-initial and medial-positions, whereas 37.5% had acquired it word finally. For multisyllabic words, 62.5% of this group acquired this sound in the

word-medial position and 50% in the word-final. Its long counterpart was acquired by 62.5% of the children word medially at the disyllabic word length.

In summary, the following segments were acquired by 90+% or more of the children across word positions: stops /b, bː, k, g, qː, ʔ/, nasals /m, n/, fricatives /f, χː, h/, and liquids and glides /l, w, j, jː/. Across word positions, 75%-86% of the children had acquired: stops /t, d, tː, tːˤʰ/ and fricative /ðˤ/. The following were not yet acquired across word positions to a 75% level: stop /tˤ/, fricatives and affricates /s, sˤ, sˤː, θ, ð, z, ʃ, χ, ʁ, ʕ, tʃ, dʒ/ plus liquid /r/.

3.4.4 Summary of Consonant Inventory Acquisition across Groups

Table 3.8 summarizes consonant inventory acquisition across groups. Phonemes are organized by manner, then by place, and voicing. The (ː) indicates short and long targets.

Table 3.8 Summary of consonant inventory acquisition across groups

Manner category	Age group	Acquired by 90+%	Acquired by 75-89%	Acquired by <75%
Stops/nasals	Younger	b(ː) t d tˤ(ː) k g qː ʔ m n	q	
	Older	Same as above plus q(ː)		
	At-risk	b(ː) k g qː ʔ m n	t d tˤː	tˤ q
Glides	Younger	w j(ː)		
	Older			
	At-risk			
Fric/aff	Younger	f sˤ ðˤ tʃ χː ħ h	sˤː ð ʃ χ ʁ ʕ	s z θ dʒ
	Older	f ðˤ ʃ tʃ χ ʁ ħ h	θ ð dʒ ʕ	s sˤ(ː) z
	At-risk	f χː ʁ h	ðˤ	s sˤ(ː) z θ ð ʃ tʃ dʒ χ ħ ʕ
Liquids	Younger	rː	l	r
	Older	rː l		r
	At-risk	l		r rː

Note. For the at-risk group, the highest criterion is actually 87.5% (7/8 children).

The table above brings all acquired consonants across groups together. In terms of stops, both younger and older age groups were almost the same whereas the at-risk group was lagging behind in acquiring stop consonants. Glides and nasals were equally acquired across groups. The younger and older age groups showed similar fricative and affricate acquisition except that the emphatic fricative /sˤ/ was acquired by the younger age group and not the older whereas only the older age group showed acquisition of the uvular fricative /ʁ/. The older group was beginning to acquire the voiced affricate and both interdentals. The at-risk group revealed limited fricative acquisition compared with the other two groups. Finally, the older age group had acquired both liquids /r:, l/, and the younger /r:/ only. The at-risk group had acquired /l/ only. No group had acquired plain /s/ or /r/. Liquids were interesting among the three groups as the younger and the older did not show similarity in the acquisition of this manner category.

3.5 Feature Mismatch Analysis for Singleton Consonants

This section will display the results of the feature substitution regarding the acquisition of single consonants. It will review the Manner, Laryngeal, and Place features for the targeted sounds. It will subdivide the sections again by looking at the younger, older, and at-risk groups. Throughout this section, the mismatches were quantified without respect to opportunities for elicitation, due to the vast amount of data, the low number of overall mismatch patterns, and the hand calculations. However, average number of mismatches per

child per group were calculated for each category, allowing inter-group comparisons. Where a target was infrequently or frequently sampled, this is indicated.

3.5.1 Feature Mismatch Analysis and Substitutions for Single Consonants—Younger Age Group

This section will go through the results concerning the acquisition of phonological features of single consonants and their substitutions for the younger age group. Findings are organized by Manner, Laryngeal and Place features.

Manner Feature Mismatch Analysis—Younger Age Group

Table 3.9 shows the number of manner feature mismatch tokens for the younger age group. Note that all tables indicate word length by number: 1 = 1 syllable; 2=2 syllables; 3 = multisyllabic words.

Table 3.9 Manner feature mismatch patterns and tokens for single Cs—younger age group

Target Feature	Mismatch	Adult	WI	Length	WM	Length	WF	Length	Sum
[-continuant]	[+continuant]	b			1	2			1
		q	2	2	4	2,3			6
	[-cont], [+cont]	b	1	3					1
[-nasal]	[+nasal]	ʔ	1	3					1
[+nasal] >	[-nas] [+cont] [-son]	m	2	2					2
[+cont]-[-son] >	[-cont]	θ							0
		ð	7	3					7
		z	1	2					1
		ʁ	4	3			1	2	5
		ʕ	2	1	1	2			3
[+cont]-[-son] >	[+cont][+son]	χ	1	2					1
		χ:			1	2			1
[+cont]-[-son] >	[-cont][+cont]	ʃ	1	2					1

Table 3.9 (cont.)

Target Feature	Mismatch	Adult	WI	Length	WM	Length	WF	Length	Sum
[+cont]-[-son] >	[+cont][+son]	ʕ			1	2			1
[+cont]-[-son] >	[+contt][-son]-[+cont][+son]	ð			1	2			1
[-cont],[+cont] >	[-cont]	ʧ			1	2	1	2	2
		ʤ	1,3	2	1	3			7
[-cont],[+cont] >	[+cont]	ʤ	1	2	1	3			2
[+son] >	[-son]	m	2	2					2
[+trilled] >	[-son]	r					1	2	1
	[-trilled] (English ɹ)	r	6	1,2	25	all	27	all	58
	[-cont] [-son]	r					1	2	1
	[+lateral]	r	1	2			2	2	3
	[+lateral] [+retroflex]	r	1	2	2	3			3
[+lateral] >	[+lateral] [+retroflex]	l	1	1			2	1	3
[+lateral] >	[-lateral] [-son][-cont]	l					3	1	3
[+lateral] >	[+trilled]	l					1	1	1
Sum			40		39		39		118

Note. [cont] = [continuant], [son] = [sonorant]

Overall, there were equivalent numbers of tokens across word positions showing feature mismatches. For the younger age group, the average number of mismatches per child was approximately three per child (118/42), i.e., a minority of patterns. The most frequent manner changes were for trilled /r/.

Although stops rarely changed, there were three examples of [-continuant] to [+continuant] (stop to fricative). The stop /b/ was produced as a fricative in word-medial position in disyllabic words, as in the example below:

جبن /dʒɪbən/ [dʒɪvən] *cheese*

The stop sound /q/ turned into a fricative in word-initial position in the disyllabic word length and in word-medial position in both disyllabic and multisyllabic words:

قطار	/qəˈtˤaːr/	[ʕəˈtˤaːr]	*train*
برتقالة	/ˌbərtəˈqalə/	[ˌbərtəˈʕalə]	*orange*

The labial nasal stop /m/ once was absent in word-initial position in the disyllabic word, showing metathesis and possible place harmony /m/ →[f], and /f/ →[l]:

مفتاح	/mɪfˈtaħ/	[fɪlˈtaħ]	*key*

A more common pattern was stopping of fricatives. There were seven tokens of coronal fricative /ð/ becoming a stop in word-initial position in multisyllabic words, as in the following example:

ذبانه	/ðəˈbːaːnə/	[dʌˈbːaːnə]	*fly*

The uvular fricative /ʁ/ was stopped (four tokens) in word-initial position at the multisyllabic word length, as in the example:

غسالة	/ʁəˈsaːlə/	[təˈsaːlə]	*washing machine*
		[dəˈsaːlə]	
		[gəˈsaːlə]	

Another noticeable pattern was the stopping of the pharyngeal fricative at both monosyllabic (one token) and disyllabic word lengths, in both word-initial and -medial positions.

علج	/ʕɛltʃ/	[ʔiltʃ]	*chewing gum*

زعتر	/ˈzəʕtər/	[ˈʑəʔtər]	*oregano*

The affricate /dʒ/ was produced either as [+continuant] (two tokens) or [-continuant] (six tokens). That occurred in both word-initial and -medial positions, at both disyllabic and multisyllabic word lengths. Similarly it was produced as a fricative in word-final position at the monosyllabic word length (one token). See examples below:

جزر	/ˈdʒɛzər/	[ˈdɛzər]	*carrots*
جدر	/ˈdʒɪdər/	[ˈdɪdər]	*pot*
حلج	/ħaldʒ/	[ħalʒ]	*mouth*
باجيلا	/ˌbaːˈdʒɪlːə/	[ˌbaːˈʒɪlːə]	*red beans*

The most frequent pattern of mismatches occurred for /r/. Different patterns were observed, such as lateral and retroflex substitutions. The trilled /r/ became [-trilled] (similar to English /ɹ/) at both monosyllabic and disyllabic word lengths in word-initial (6 tokens), word-medial (25 tokens), and word-final (27 tokens) positions. A labiodental, labiovelar or coronal glide was sometimes a substitution. Three /r/s were realized as [l]. Examples are listed below:

روضة	/ˈrawðˤə/	[ˈɭawðˤə]	*kindergarten*
كرة	/ˈkurə/	[ˈkuɻə]	*ball*
جدر	/ˈdʒɪdər/	[ˈdʒɪdəɻ]	*pot*
قطار	/qəˈtˤaːr/	[qəˈtˤaːɻ]	*train*

جارى	/ˈgaːri/	[ˈgaːɹi]	*bicycle*
جزر	/ˈdʒɛzər/	[ˈdɛzəl]	*carrots*
ريل	/riːl/	[ʊiːl]	*foot*
طيارة	/tˤəˈjːaːrə/	[tˤəˈjːaːwə]	*airplane*
كرة	/ˈkurə/	[ˈkujə]	*ball*

In summary the most common patterns were loss of trill for the /r/, stopping of /ð/ and /ʁ/ and spirantization of /q/.

Laryngeal Feature Mismatch Analysis—Younger Age Group

This section will inspect laryngeal feature mismatches. Voicing and devoicing will be considered across the segments in this part. Examples will be given for the most frequent patterns. Overall, there were 24 mismatches or 0.6 per child in the younger age group. Table 3.10 shows the number of tokens of Laryngeal feature mismatch for the younger age group.

Table 3.10 Laryngeal feature mismatch patterns and tokens for single consonants—younger age group.

Target Feature	Mismatch	Adult	WI	Length	WM	Length	WF	Length	Sum
[+voiced] >	[-voiced]	b	1	3					1
		d	1	2					1
		g	1	2			1	1	2
		z	2	2					2
		dʒ	3	2					3
		r			1	2	1	2	2
		ʕ			1	2			1
[+voiced] >	partial devoicing	b	1	2					1
		z	2	2					2
		m	1	2					1

Table 3.10 (cont.)

Target Feature	Mismatch	Adult	WI	Length	WM	Length	WF	Length	Sum
		n					1	2	1
		r			1	3	1	1	2
[-voiced] >	[+voiced]	q			2	2,3			2
		θ			1	3			1
[-voiced] >	partially [+voiced]	s			1	2			1
[+sg] >	[-sg]								0
[-sg} >	[+sg]								0
[-sg] >	[-sg][+sg] (aspirated)	ʕ			1	2			1
Sum			12		8		4		24

Note. [sg] = [spread glottis]

The most common pattern was devoicing (full or partial). The younger children often had more full devoicing while, as we shall see, older children showed almost exclusively partial devoicing.

The labial stop /b/ was devoiced in word-initial position at multisyllabic and disyllabic word lengths. Similarly, it was devoiced in word-final position in the monosyllabic word length, as in the examples below.

برتقاله	/ˌbərtəˈqalə/	[ˌpə̥θˈqalə]	*orange*
کلب	/tʃɛlb/	[tʃɛlb̥]	*dog*

Similarly, /d/, /g/, and /dʒ/ were devoiced in word-initial position in disyllabic words. (See examples below.) The fricative /z/ was devoiced totally and partially in the word-initial and -final positions, respectively, at the disyllabic word length.

دوا	/ˈduwa/	[ˈd̥uwa]	*medicine*
خبز	/ˈχəbəz/	[ˈχəbəz̥]	*bread*

زعتر	/ˈzəʕtər/	[ˈʐ̥əʕtər]	*oregano*	
جنطة	/ˈdʒəntˤə/	[ˈɖ̥ʒəntˤə]	*handbag*	

In addition, the pharyngeal fricative /ʕ/ was devoiced word-medially at the disyllabic word length, as in:

شعر	/ˈʃaʕar/	[ˈɕaʕ̥aw]	*hair*	
زعتر	/ˈzəʕtər/	[ˈzəħtər]	*oregano*	Voicing assimilation

The trilled /r/ was devoiced in word-medial and word-final positions at the disyllabic word length and the sonorant /m/ was also devoiced once. See examples below:

شعر	/ˈʃaʕar/	[ˈʃaʕaɾ̥]	*hair*	
كرسى	/ˈkirsi/	[ˈkiɾ̥ɾ̥i̥]	*chair*	Voicing assimilation?
قطار	/qəˈtˤaːr/	[qəˈtˤaːɾ̥]	*train*	

Less frequent was the voicing of [-voiced] targets, as in the sound /q/ word-medially at disyllabic and multisyllabic word lengths, as in the example below:

دقوس	/daˈquːsː/	[daˈʁuːs], [daˈguːs]	*tomato sauce*
قصة	/ˈqəsˤːə/	[ˈʁəsˤːə]	*story*

The voiced pharyngeal fricative was produced with a spread glottis (voiceless) or constricted glottis in the word-medial position at the disyllabic word length. See following examples:

شعر	/ˈʃaʕar/	[ˈʃaħar]	*hair*
زعتر	/ˈzəʕtər/	[ˈzəʔtər]	*oregano*
زعتر	/ˈzəʕtər/	[ˈzəħtər], [ˈzəʔʰtər]	

Place Feature Mismatch Analysis—Younger Age Group

This section describes place mismatches in consonants for this younger age group. Overall, there were 180 mismatches, or 4.5 per child in this group. Table 3.11 shows the number of tokens of place feature-mismatches for the younger age group.

Table 3.11 Place feature mismatch patterns and tokens for single Cs—younger age group

Target Feature	Mismatch	Adult	WI	Length	WM	Length	WF	Length	Sum
Labial >	[Cor, +ant, -grvd]	b	1	3					1
[+anterior] >	Labial	d	1	3			1	2	2
		ð			1	2			1
		r	2	1,2	11	2,3	7	7	20
Cor [+anterior] >	[-ant]	r	3	1,2	10	all	14	7	27
		s	1	2					1
		z	1	2					1
	[+ant][-ant]	r			1	2			1
	Dorsal	t	1	3					1
		r			1	2			1
	[Glottal]	r			1	2			1
[-anterior] >	[+ant]	ʃ	1	2	3	2,3			4
		tʃ							0
		dʒ							0
[+grooved] >	[-grooved]	s	9	1,2	16	2,3	6	7	31
		z	4	2	10	2	3	5	17
		ʃ	1	2	1	2			2
		tʃ	1	1					1
		dʒ	2	2	1	2			3
		$s^{ʕ}$	8	2,3	2	2	2	2	12
		$s^{ʕ}$:			6	2			6

Table 3.11 (cont.)

Target Feature	Mismatch	Adult	WI	Length	WM	Length	WF	Length	Sum
[-grooved] >	[+grooved]	θ							0
		ʃ							0
		χ							0
		χː							0
[-grooved] >	partial [+grvd]	θ	2	3	4	3	2	3	8
Dorsal [-hi][-lo] >	[+ant]	ʁ	2	3					2
		q	2	2	1	3			3
Dorsal [-hi][-lo] >	[+high]	q			2	2,3			2
Dorsal [-hi][-lo] >	[-hi] [-lo],[+hi]	ʁ							0
Dorsal [-hi][-lo] >	[Pharyngeal]	q			2	2			2
		qː			1	2			1
		χ	6	1,2	4	2,3	1	2	11
		χː			1	2			1
		ʁ					1	2	1
Pharyngeal >	Dors [-hi] [-lo]	ʕ					1	2	1
	Labial	ʕ			1	2			1
									0
	[Plain]	$t^ʕ$					1	1	1
		$t^ʕ$ː					1	1	1
		$ð^ʕ$							0
		$s^ʕ$	4	2,3	1	2	1	2	6
		$s^ʕ$ː			2	2			2
Plain >	[Pharyngeal]	z	1	2	1	2			2
		ʁ	1	3	1	3			2
Sum			54		85		41		180

Note. [ant] = [anterior]; Cor = Coronal

The coronal /d/ was surprisingly fronted to [b] in word-initial position (unstressed syllable) in multisyllabic words and at the disyllabic length in word-final position. An example was:

دشداشة /dɪʃˈdaːʃə/ [bəˈdaːʃə] *Arabic dress for men*

Similarly, the fricative /ð/ moved forward ([Coronal, +anterior] > Labial) in word-medial position at the disyllabic word length, as in:

روضة	/ˈrawðˤə/	[aβːə]	*Kindergarten*

The trilled /r/ showed two place mismatch types: it was labialized (fronted) in the first, and slightly retracted in the other, across all words positions and lengths. The following examples will display this:

ريل	/riːl/	[ʊiːl]	*foot*
روضة	/ˈrawðˤə/	[ʊ̯awðˤə]	*Kindergarten*
طيارة	/tˤəˈjːaːrə/	[tˤəˈjːaːwə]	*airplane*
سرير	/ʔəˈsriːr/	[ʔəˈsɻiːɻ]	*bed*
كرة	/ˈkurə/	[ˈkujə]	*ball*

The fricatives /s/ and /z/ were backed as well in word-initial position at the disyllabic word length (one token for each):

سيكل	/ˈsejkəl/	[ˈʃejkəl]	*motorcycle*
زعتر	/ˈzəʕtər/	[ˈʃ̟əʕtər]	*oregano*

The fricative /ʃ/ in contrast, fronted in word-medial position, at both disyllabic and multisyllabic word lengths. The example below will illustrate the place shift [-anterior] > [+anterior].

مشط	/ˈmɪʃətˤ/	[ˈmɔstˤ]	*comb*
خشم	/ˈχaʃəm/	[ˈχasəm]	*nose*

Another important pattern concerns grooving, or lack of grooving. All the fricatives and affricates were subject to grooving (or degrooving), which resulted in misplacement. The fricatives /s/, /z/ and /sˤ/ were degrooved across all word positions and lengths. See examples below.

The /s/ showed nine tokens of degrooving in word-initial position at both monosyllabic and disyllabic words lengths: (with [s̟] being only slightly grooved, [sᶿ] being slightly less grooved still and [θ] fully ungrooved. Transcription reliability for slight versus more degrooving is not considered highly reliable, however.)

سرير	/sriːr/	[s̟riːr]	*bed*
سيكل	/ˈsejkəl/	[ˈs̟ejkəl]	*motorcycle*

Word-medial position at disyllabic and multisyllabic word lengths showed 16 tokens of degrooving:

آسف	/ˈʔæːsɪf/	[ˈʔæːs̟ɪf]	*sorry*
غسالة	/ʁəˈsaːlə/	[ʁəˈs̟aːlə]	*washing machine*

Word-final position showed six tokens across all word lengths and positions.

The emphatic /sˤ/ was degrooved across all word lengths and positions. For example, eight tokens changed at word-initial position in both disyllabic and multisyllabic word lengths.

صحون	/sˤħuːn/	[θuːn]	*plates*
صحن	/ˈsˤaħan/	[ˈθˤaħan]	*plate*

صحن	/ˈsˤaħan/	[ˈs̺ˤaħan]	*plate*
صابونة	/sˤaˈbuːnə/	[s̺ˤaˈbuːnə]	*bar of soap*

Two tokens are seen in each of word-medial and -final positions at the disyllabic word length. The following example will clarify:

وصخ	/ˈwʌsˤəχ/	[ˈwʌs̺ˤəχ]	*dirty*

The long emphatic fricative /sˤː/ was degrooved in word-medial position (six tokens) at disyllabic word length, as demonstrated by the examples below:

قصة	/ˈqəsˤːə/	[ˈqəs̺ˤːə]	*story*
مصاص	/maˈsˤːəsˤ/	[maˈsˠːəsˠˤ]	*straws*

In contrast, the ungrooved fricative /θ/ was partially grooved in the following fairly common pattern: word-initially (two tokens) and word-medially (four tokens, as in example below) at the multisyllabic word length:

ثلاثة	/θəˈlæːθə/	[θˢəˈlæːθˢə]	*three*

and word-finally, (two tokens) as in the example below:

مثلث	/muˈθəlːəθ/	[muˈθˢəlːəθˢ]	*triangle*

The uvular fricative /ʁ/ was fronted and raised (stopped) (two tokens) word-initially at the trisyllabic word length, as in the example below:

غسالة	/ʁəˈsaːlə/	[gəˈsaːlə]	*washing machine*

The uvular stop /q/ was fronted word-initially at the disyllabic word length (two tokens). It was fronted and raised word medially once at the multisyllabic length. The following examples will demonstrate:

قطار	/qəˈtˤaːr/	[gəˈtˤaːr]	*train*

The same sound was also backed, as in:

برتقالة	/ˌbərtəˈqalə/	[ˌbətəˈʕaːl]	*orange*

The fricative /χ/ was similarly backed to a pharyngeal fricative /ħ/ word-initially at the mono- and disyllabic word lengths (six tokens), word-medially at the multisyllabic word length (four tokens), and word-finally in the disyllabic word-length (one token). See examples below:

خيط	/χeːtˤ/	[ħeːtˤ]	*thread*
خروف	/ˈχaʃəm/	[ˈħaʃəm]	*nose*
تفاخية	/təfaˈχiːjə/	[təfaˈħiːjə]	*balloon*
وصخ	/ˈwʌsˤəχ/	[ˈwʌsˤəħ]	*dirty*

The emphatic fricative /sˤ/ was de-emphasized in word-initial position at the disyllabic word length (three tokens). Similarly, the long emphatic fricative /sːˤ/ was shortened and de-emphasized word-medially at the disyllabic word length (once). See the following examples:

صحن	/ˈsˤaħan/	[ˈs̬aħan]	*plate*
صبع	/ˈsˤəbəʕ/	[ˈs̬əbəʕ]	*finger*

قصة	/ˈqəsˤːə/	[ˈqəsːə]	*story*
مصاص	/maˈsˤːəsˤ/	[maˈs̟ːəs̟ˤ]	*straws*

Sounds such as /z/ and /ʁ/ exhibited the reverse situation, i.e., pharyngealization. The sound /z/ was produced as /zˤ/ in word-medial position (once):

جزر	/ˈdʒɛzər/	[ˈdʒɛzˤər]	*carrots*

The uvular /ʁ/ was pharyngealized at the multisyllabic word length in both word-initial and word -medial positions (once each). See the examples below:

غسالة	/ʁəˈsaːlə/	[ʁˤəˈsaːlə]	*washing machine*
مغسلة	/məʁˈsələ/	[məʁˤˈsələ]	*sink*

In summary, the most common place differences were for /r/, which showed labial substitutions ([w], [ʊ]) or [-anterior] ([ɹ]). Other common Place mismatches were degrooving of sibilants and pharyngeal replacement of /χ/.

3.5.2 Feature Mismatch Analysis for Consonant Substitution—Older Age Group

This section will discuss results relating to acquisition of singleton consonant phonological features and their substitutions for the older group, in the same order as above. This section will refer to examples of the previous section except for the unrepeated tokens.

Manner Feature Mismatch Analysis—Older Age Group

The results for manner feature mismatch show the same patterns as in the younger age group, but at a higher accuracy rate. Some patterns in fact were more frequent in this group, however. Overall, there were 61 manner mismatches (1.9/child).

As can be seen in Table 3.12 below, the labial stop /b/ was produced as [+continuant] word initially at the multisyllabic word length (twice), as in the following example:

باجيلا	/ˌbaːˈdʒɪlːə/	[ˌβaːˈdʒɪlːə]	*red beans*

Stopping of fricatives was more common than frication of stops. The /θ/ was stopped in multisyllabic words across word positions. See example below:

ثلاثة	/θəˈlæːθə/	[təˈlæːtə]	*three*

The fricative /ð/ was stopped in word-initial position in multisyllabic words (six tokens):

ذبانة	/ðəˈbːanə/	[dəˈbːanə]	*fly*

The pharyngeal fricative /ʕ/ was stopped in all positions (one token for each) at the disyllabic word length including the medial sequences (perhaps reflective of a sequence constraint):

عنب	/ˈʕa(j)nəb/	[ˈʔa(j)nəb]	*grapes*
زعتر	/ˈzəʕtər/	[ˈzəʔtər]	*oregano*

The affricate /dʒ/ was produced with feature [-continuant], Dorsal ([g]) and [+anterior] which resulted in a [d]: in word-initial position in disyllables (six tokens), and in the word-medial position in the disyllabic and multisyllabic word lengths (two tokens). See examples below:

جزر	/ˈdʒɛzər/	[ˈgɛzər]	*carrots*

جزر /ˈdʒɛzər/ [ˈdɛzər] *carrots*

باجيلا /ˌbaːˈdʒɪlːə/ [ˌbaːˈɖɪlːə] *red beans*

The affricate /tʃ/ was produced as a fricative [+continuant] in the word-initial position in monosyllables (three tokens), and in word-medial disyllables (two tokens):

مكبوس /matʃˈbuːs/ [maʃˈbuːs] *a kind of Kuwaiti food*

كلب /tʃɛlb/ [sɛlb] *dog*

Table 3.12 Manner feature mismatch patterns and tokens for single Cs—older age group

Target Feature	Mismatch	Adult	WI	Length	WM	Length	WF	Length	Sum
[-cont] >	[+cont]	b	2	3					2
		ʔ	1	2					1
[+nasal] >	[+nas],[-nas] [-cons] (mw])	m	1	2					1
[+cont]-[-son] >	[-cont]	θ	1	3	3	3	1	3	5
		ð	6	3					6
		ðˤ			1	2			1
		f			1	2			1
		ʕ	1	2	1	2	1	2	3
[+cont]-[-son] >	[+cont][+son]	χ	1	1					1
		dʒ	6	2	2	2,3			8
[-cont],[+cont] >	[+cont]	tʃ	3	1	1	2			4
	[+cont][+son]	dʒ	1	2					1
[+son] >	[-son]	m					1	1	1
		r							
[+trilled] >	[-trilled] [ɹ]	r			1	2			1
	[-cons]	r	2	1,2	5	2,3	7	all	14
		r:			1	2			1
	[+cont][-son]	r	1	2	3	2,3	4	all	8
[+lateral] >	[+nasal]	l			1	3			1
	[+trilled]	l					1	1	1
Sum			26		20		15		61

Note. [cont]= [+ continuant], [son]= [sonorant].

The Arabic trilled /r/ was produced in more than one manner; as an English-like [ɹ], approximant [ʋ] and uvular fricative [ʁ] across words lengths and positions, including e.g., the word-initial position at the monosyllabic and disyllabic word lengths (two tokens) and the word-medial position at the disyllabic and the multisyllabic word lengths (five tokens). Word-finally, /r/ was tapped ([ɾ]) at all word lengths (seven tokens). The following examples from two interesting participants who have different forms of /r/ will demonstrate. The first set of examples is from the same child:

ريل	/riːl/	[wiːl]	*foot*
برد	/bərd/	[bəɹd]	*cold*
بعير	/beˈʕiːr/	[beˈʕiːʁ]	*camel*
طيارة	/tˤəˈjːaːrə/	[tˤəˈjːaːʁə]	*airplane*
امكسر	/ʔəmˈkʰəsər/	[ʔəmˈkʰəθəw]	*long underpants*

The following example is from another child:

ريل	/ridʒl/	[ʋidʒl]	*foot*

(The /dʒ/ in the above example is a Bedouin-dialect acceptable variant of the word.)

جدور	/dʒduːr/	[dʒduːʋ]	*pots*
جزر	/ˈdʒɛzər/	[ˈdʒɛzəɯ]	*carrots*
قطار	/qəˈtˤaːr/	[qəˈtˤaːʋ]	*train*
روضة	/ˈrawðˤə/	[ˈʋawðˤə]	*kindergarten*

The trilled /r/ was also produced as a uvular fricative [ʁ] across all word positions and lengths: at word-initial position in the disyllabic word length (one token), word medially in the disyllabic and multisyllabic word lengths (three tokens), and word finally in all lengths (four tokens). See examples below:

روضة	/ˈrawðˤə/	[ˈʁawðˤə]	*kindergarten*
جارى	/ˈgaːri/	[ˈgaːʁi]	*bicycle*
بعير	/beˈʕiːr/	[beˈʕiːʁ]	*camel*
طيارة	/tˤəˈjːaːrə/	[tˤəˈjːaːʁə]	*airplane*

The /l/ was not used as a substitution in this older group.

Laryngeal Feature Mismatch Analysis—Older Age Group

This section will present the laryngeal feature mismatches of this age group. Table 3.13 shows number of Laryngeal feature mismatch tokens for the older age group.

Table 3.13 Laryngeal feature mismatch patterns and tokens for single Cs—older age group

Target Feature	Mismatch	Adult	WI	Length	WM	Length	WF	Length	Sum
[+voiced] >	partial devoicing	ʕ			1	2			1
		b							
		z	1	2	3	2	2	2	6
		d					1	2	1
[-voiced] >	partially [+voiced]	t	1	3					1
Sum			2		4		3		9

Laryngeal mismatches were fewer than the mismatches in the younger cohort. The most frequent pattern of mismatch was the partial devoicing of /z/. The devoicing of this fricative

was limited to disyllabic word length across positions: word-initial (one token), word-medial (three tokens), and word-final (two tokens). This may mean that this older age group was in transition to mastering its voiced consonants; therefore they did not show any full devoicing. See examples below:

زعتر	/ˈzəʕtər/	[ˈz̥əʕtər]	*oregano*
موزة	/ˈmoːzə/	[ˈmoːz̥ə]	*banana*
خبز	/ˈχəbəz/	[ˈχəbəz̥]	*bread*

In summary, nine mismatches were found for the laryngeal feature for this older age group, reflecting primarily partial devoicing. This means an average of .28 mismatches per child.

Place Feature Mismatch Analysis—Older Age Group

This section will spotlight the place mismatches for the older age group. Overall, there were 196 mismatches in this group, which means 6.12 mismatches per child. Like the previous sections, it will concentrate on the more frequent patterns. In order to avoid repetition, it will cite examples not found or less frequently found for the younger age group. Table 3.14 shows number of tokens of Place feature mismatches.

Table 3.14 Place feature mismatch patterns and tokens for single Cs—older age group

Target Feature	Mismatch	Adult	WI	Length	WM	Length	WF	Length	Sum
Cor									
[+anterior] >	Dental for /l/	l	1	2			1	2	2
		r	1	1			1	3	2
	[+labiodental]	r	1	2	6	2,3	5	all	12
	Dors [+high]	r					1	2	1
		z	1	2					1
	Dorsal [-hi][-lo]	r	1	2	3	2,3	4	7	8
	(metathesis)	s			1	2			1

Table 3.14 (cont.)

Target Feature	Mismatch	Adult	WI	Length	WM	Length	WF	Length	Sum
[-ant]	[+ant]	ʃ	2	2	3	2,3			5
		ʧ	2	1	1	2			3
		ʤ	1	2	2	3			3
[+grooved] >	[-grooved]	s	10	1,2	32	2,3	16	1,2	58
		z	6	2	13	2	6	2	25
		ʧ					3		3
		ʤ	2	2	1	2			3
		sˤ	18	all	5	2	9	2	32
		sˤ:			12	2	1	2	13
[-grooved] >	[+grooved]	θ			2	2,3	1	3	3
Dorsal [-high][-low] >	[+ant]	χ					1	2	1
Pharyngeal >	Dors [-hi][-lo]	ʔ	1	2					1
Pharyngeal >	plain	tˤ	1	2			3	1	4
		ðˤ			1	2			1
		sˤ	2	2,3	2	2	3	2	7
		sˤ:			3	2	1	2	4
Plain >	Pharyngeal	ʤ	1	2					1
		ʃ	2	2					2
Sum			53		85		56		196

Note. Cor= coronal; [ant]= [anterior]; Dors = Dorsal; Plain = non-pharyngealized; [hi] = [high]; [lo] = [low].

The fricative /s/ was degrooved for a large number of tokens across all word positions and lengths; for instance, in word-initial position (10 tokens), word-medial position (32 tokens), and word-final position (16 tokens) at the monosyllabic and disyllabic word lengths. The examples of the mismatch patterns are, more or less, the same as they were for the younger age group except for the number of tokens. To demonstrate this on the level of the speech sound, /s/: /s/ → [s̪], [s̪], [θ].

The next-highest number of mismatches was for the emphatic fricative /sˤ/, also degrooved across all word positions and lengths. The numbers were as high as 18 tokens for word-initial position at all word lengths and 5 and 9 tokens for word-medial and -final

positions respectively at disyllabic word lengths. The same words showed mismatches as in the younger age group; therefore, examples are not given here. Substitutions were as follows: /s^{ʕ}/ →[s̪^{ʕ}], [θ^{ʕ}], [θ] (across all positions and lengths).

The fricative /z/ was also degrooved in a relatively large number of tokens across all word positions and lengths: word initially (6 tokens), word medially (13 tokens), and word finally (6 tokens) at the disyllabic word length. The mismatch patterns were just like the ones observed at the younger age, where the substitutions are summarized by the following example:/z/→ [z̪], [ð], [z^{ð}]. However they were more frequent in this older group.

A minority pattern observed in this older age group was the de-emphasization of /s^{ʕ}/. This was seen in two tokens in the word-initial position for both disyllabic and multisyllabic word lengths. The word-medial position also showed two tokens in the disyllabic word length, and the word-final position three tokens in the disyllabic word length.

3.5.3 Feature Mismatch Analysis for Consonant Substitution—At-Risk Group

This section will describe the feature mismatches for the at-risk group. The mismatch patterns for this group were higher in frequency, particularly considering the small number of children in the group. This group consists of eight children only; therefore, we will consider the tokens accordingly.

Manner Feature Mismatch Analysis—At-Risk Group

This section will display the manner feature mismatches for the at-risk group. Overall, there were 100 manner mismatches, or 12.5 per child, i.e., notably more per child than for the other two groups. Table 3.15 shows tokens of manner feature mismatches of the at-risk group.

Table 3.15 Manner feature mismatch patterns for single Cs—at-risk group

Target	Mismatch	Adult	WI	Length	WM	Length	WF	Length	Sum
[-continuant] >	[+cont]	q	2	2					2
[+cont]-[-son] >	[-cont]	s	1	2	3	2	1	1	5
		ð	5	3	1	2			6
		z	1	2	1	2			2
		ʁ	1	3			2	2	3
		ʕ	2	1,2					2
		ħ	1	1					1
		ʃ	1	2	1	2			2
		sˤ	1	2					1
[-cont],[+cont] >	[-cont]	ʧ	5	1	2	2	3	2	10
		dʒ	5	2	5	2,3			10
[-cont],[+cont] >	[+cont]	ʧ	1	1					1
		dʒ	1	2					1
[+trilled] >	[-trilled] [ɹ]	r			1	3	2	2	3
[+trilled] >	[+lateral]	r	7	1,2	19	2,3	23	2,3	49
		r:			2	2			2
Sum			34		35		31		100

First, stopping of fricatives was a common pattern for this group. The fricative /s/ was stopped across all word positions and lengths. For example, there was one token of stopping in the word-initial position at the disyllabic word length. The word-medial position had three tokens of stopped /s/ at the same word length. In the word-final position, the /s/ was stopped at the monosyllabic word length. Examples are given below:

سيكل /ˈsejkəl/ [ˈtejkəl] *motorcycle*

آسف /ˈʔæːsɪf/ [ˈʔæːtɪf] *sorry*

فلوس /fluːs/ [fluːt] *money*

The rest of the fricatives were stopped at two word lengths only, but they are still worth mentioning given the small size of the sample. The fricative /ð/ was stopped in word-initial position (five tokens) for the multisyllabic word lengths, and in the disyllabic word length at the word-medial position (one token). The examples below will show that:

ذبانة	/ðəˈbːanə/	[dəˈbːanə]	*fly*
نظيف	/nəˈðiːf/	[nəˈdiːf]	*clean*

(The same error mismatch occurred in the younger age group.)

The fricative /z/ was stopped in both word-initial and -medial positions at the disyllabic word length (one token for each). (See examples.)

زعتر	/ˈzəʕtər/	[ˈdəʕtər]	*oregano*
جزر	/ˈdʒɛzər/	[ˈdɛʑər]	*carrots*

The uvular fricative /ʁ/ was stopped in the word-initial position (one token) at the multisyllabic word lengths, and in the word-final position (two tokens) at the disyllabic word length. (See examples.)

غسالة	/ʁəˈsaːlə/	[gəˈsaːlə]	*washing machine*
دلاغ	/ʔədˈlaːʁ/	[ʔədˈlaːg]	*a sock*

The fricative /ʃ / was stopped in the word-initial and -medial positions (one token for each) at the disyllabic word lengths. (See examples.)

شعر	/ˈʃaʕar/	[ˈtaʕar]	*hair*
مشط	/ˈmɪʃətˤ/	[ˈmɪtˤətˤ]	*comb*

Some other sounds were stopped, but for only a small number of tokens (not exceeding two), and in one word length only. They are /ʕ/, /h/, and /sˤ/.

The following paragraph will look at the manner of "deaffrication" where the affricate sounds /tʃ/ and /dʒ/ were produced with a [-continuant] manner feature. For example, the affricate sound /tʃ/ was produced as /t/ in word-initial position in the monosyllabic word length (five tokens), in the word-medial position in the disyllabic word length (two tokens), and in the word-final position in the disyllabic words length (three tokens). (See examples.)

كلب	/tʃɛlb/	[tɛlb]	*dog*
سمكة	/ˈsmɪtʃə/	[ˈsmɪtə]	*fish*
سمك	/ˈsɪmətʃ/	[ˈsɪmət]	*fish*-PL

The affricate /dʒ/ was similarly produced. This pattern was very common considering the number of children in this group. For instance, stopping appeared in the word-initial position for disyllabic words (five tokens), and in word-medial position at the disyllabic and the multisyllabic word lengths (five tokens), as in the following example:

جزر	/ˈdʒɛzər/	[ˈdɛzəl]	*carrots*
جنطة	/ˈdʒəntˤə/	[ˈdəntˤə]	*hand bag*
حجاب	/ħaˈdʒaːb/	[ʔəħˈdaːb]	*hairscarf*
باجيلا	/ˌbaːˈdʒɪlɪːə/	[ˌbaːˈdɪlɪːə]	*red beans*

These affricates were produced less commonly with the opposite manner feature [+continuant], so that they became fricatives (once each) in word-initial position at the monosyllabic and disyllabic word lengths.

The trilled /r/ was produced most frequently as [l] across all word positions and lengths for a high number of tokens. The word-initial position had seven tokens of /r/ > [l] at the monosyllabic and disyllabic word lengths. The word-medial position had 19 tokens of [l] in the disyllabic and multisyllabic word lengths, and the word-final position 23 tokens of [l] in the disyllabic and multisyllabic word lengths. The following examples show this:

ريل	/riːl/	[liːl]	*foot*
كرة	/ˈkurə/	[ˈkulə]	*ball*
خروف	/χaˈruːf/	[χaˈluːf]	*sheep*
بعير	/beˈʕiːr/	[beˈʕiːl]	*camel*
امكسر	/ʔəmˈkʰəsər/	[ʔəmˈkʰəsəl]	*long underpants*

A few tokens of [ɹ] also appeared.

Laryngeal Feature Mismatch Analysis—At-Risk Group

The laryngeal feature mismatch of this at-risk group was minimal. Overall, there were 23 mismatches (2.9 per child). See Table 3.16.

Table 3.16 Laryngeal feature mismatch patterns and tokens for Cs—at-risk group

Target Feature	Mismatch	Adult	WI	Length	WM	Length	WF	Length	Sum
[+voiced] >	[-voiced]	ɡ	1	2					1
		z	3	2	1	2			4
		dʒ	3	2					3
		r					1	2	1
		ʕ	2	1,2					2
[+voiced] >	partial devoicing	b					1	2	1
		d					1	2	1
		z	2	2					2
		dʒ	2	2					2
		r					1	2	1
		ʁ	1	3					1
		ʕ	2	1,2					2
[-voiced] >	[+voiced]	ɋ	2	2					2
Sum			18		1		4		23

Most of the mismatches such as devoicing, partial devoicing and voicing occurred in one word length and one word position only. The only fricative that was devoiced in two word positions was /z/ in word-initial position (three tokens) and in word-medial (once) position at the disyllabic word length. The following examples will demonstrate:

زعتر /ˈzəʕtər/ [ˈsəʕtər] *oregano*

موزة /ˈmoːzə/ [ˈmoːsə] *banana*

The only fricative that was partially or totally devoiced in two word lengths was the /ʕ/. It was observed that the devoicing in this group did not exceed 37.5% (three tokens) in some positions, with an average of 25% (two tokens) per position. The examples are similar to the ones listed in the younger age group.

Place Mismatch Analysis—At-Risk Group

Overall, there were 127 place mismatches, or 15.9 per child (see Table 3.17).

Table 3.17 Place feature mismatch patterns for single Cs—at-risk group

Target Feature	Mismatch	Seg	WI	Length	WM	Length	WF	Length	Sum
Cor									
[+anterior]	Dorsal	t			1	2			1
	[Glottal]	d	1	3					1
[-ant]	[+ant]	ʃ	5	2	13	2,3			18
		tʃ	5	1			1	2	6
		dʒ	10	2	3	2	1	1	14
[+grooved] >	[-grooved]	s	3	1,2	3	1,3	5	2	11
		z	2	2	2	1,2	3	2	7
		ʃ	2	2	3	2,3			5
		tʃ	1	1					1
		dʒ	1	2					1
		sˤ	4	2,3	1	2	1	2	6
		sˤː			1	2			1
[-grooved] >	[+grooved]	θ			2	3	1	3	3
	partially [+grooved]	θ	1	3	1	3			2
Dorsal [-high] [-low]	[+ant]	ʁ							
		q	1	2					1
	[+high]	q	2	2	1	3			3
		ʁ	1	3			2	2	3
	Pharyngeal	χ	7	1,2	1	3			8
		χː			1	2			1
Pharyngeal >	[Glottal]	ħ	3	1					3
[Glottal] >	Pharyngeal	h	1	2					1
Pharyngeal >	Plain	tˤ	4	all	2	2	4	1,2	10
		tˤː			2	2			2
		ðˤ			2	2			2
		sˤ	7	all			3	2	10
		sˤː			3	2			3
Plain >	Pharyngeal	dʒ	1	2					1
		ʃ			1	2			1
		tʃ			1	2			1
Sum			62		44		21		127

Only the higher numbers of tokens and most unusual patterns will be presented, since the rest of the error patterns overlap with the examples of the younger age group.

The stop /t/ was backed and produced as a dorsal (once) through a possible metathesis in word-medial position at the disyllabic word length, as in:

قطار	/qəˈtˁaːr/	[təkaːl]	*train*

The fricative /ʃ/ was fronted in word-initial position (5 tokens) at the disyllabic word length and in word-medial position (13 tokens) at both disyllabic and multisyllabic word lengths. See examples below:

شعر	/ˈʃaʕar/	[ˈsaʕər]	*hair*
خشم	/ˈχaʃəm/	[ˈχasəm]	*nose*
دشداشة	/dɪʃˈdaːʃə/	[dɪsˈdaːsə]	*Arabic dress for men*

The affricates / tʃ/ and /dʒ/ were fronted, but /dʒ/ more frequently than its voiceless counterpart /tʃ/. The /dʒ/ was produced with place feature [+anterior] word initially (10 tokens) and medially (3 tokens) at the disyllabic word length, and word finally at the monosyllabic length. See examples in the manner mismatch analysis.

Grooving issues were also common. The largest portion of degrooving was for /s/ (more targets); namely, in word-initial position (three tokens) at the monosyllabic and disyllabic word lengths and in word-medial position (three tokens) at the disyllabic and multisyllabic word lengths. See examples below:

سرير	/sriːr/	[s̪riːr]	*bed*

سيكل	/ˈsejkəl/	[ˈsʲejkəl]	*motor bike*
مكبوس	/matʃˈbuːs/	[matʃˈbuːsʲ]	*Kuwaiti food*

Further examples are provided in the previous sections 3.4.1-3.4.3 and are similar to those here.The mismatch patterns that were found for the at-risk group are similar to those of the other two groups but at a higher rate. Degrooving was apparent for the other fricatives and affricates some of the time, e.g., for /z/, /ʃ/, /tʃ/, /dʒ/, /$s^{ʕ}$/. Partial degrooving (as for the other groups) means that the sibilants were distorted but not totally without grooving (stridency), that is, that the speech sounds were still developing, i.e., not yet fully acquired. The ungrooved interdentals were sometimes grooved fully or partially, as in the following: /θ/ → [s] or [$θ^{s}$]. (Note that [$θ^{s}$] and [$s^{θ}$] may be functionally equivalent.) The dorsal sounds were elevated (to velars) or pharyngealized, whereas some pharyngeal emphatics were de-emphasized.

Summary of Feature Mismatch across Groups

Table 3.18 shows a summary of the feature mismatch tokens across groups. The scores were not linearly proportioned across groups. The at-risk group showed a much higher proportion of mismatches across feature types.

Table 3.18 Summary of feature mismatch tokens across groups

	Manner		Place		Laryngeal	
	Total	Avg/child	Total	Avg/child	Total	Avg/child
Younger	118	2.9	180	4.5	24	0.6
Older	61	1.9	196	6.1	9	0.3
At-risk	100	**12.5**	127	**15.9**	23	**2.9**

Note. There were no significant differences between the older and younger age groups on *t*-tests.

If we examine Table 3.18, the younger age group showed an average of 2.9 mismatches per child in manner feature mismatches, whereas the older scored the least mismatches (1.9/child). The at-risk group showed 12.5/child, a much higher proportion. For the laryngeal feature mismatches, the younger age group again showed more mismatches (.6/child) than the older group (.3/child). The at-risk children showed the most, i.e., 2.9 mismatches/child. Ultimately, the at risk-group scored the highest mismatch for the place features (15.9/child), and next came the older group (6.1/child), whereas the younger age group scored the lowest proportion for place mismatches (4.5/child). As noted, there were no statistical differences in place, manner or laryngeal feature mismatch proportions between the older and younger age groups, however.

In terms of substitution types for manner, the younger group showed 15 different manner substitution types, the older group 12 types and the at-risk group 6 types. The slight differences between the two age groups reflected additional patterns of affrication or segment splitting and nasalization in the younger group (low token frequency). The at-risk group did not show affrication (and had not acquired affricates) and had fewer patterns with sonorants. For voicing, the major difference appeared to concern both voiced and voiceless targets, with the younger and at-risk group showing both full and partial devoicing, and the older group showing only partial devoicing or voicing. Partial voicing of voiceless targets was observed for both age groups and full voicing for the at-risk and younger groups. For place, the younger group showed 18 patterns, the older 11 and the at-risk 13 types (a large proportion considering the size of the group). Patterns including fronting, backing, degrooving (partial, full), pharyngealization and de-emphasis of emphatics. The younger appeared to have more patterns for the uvulars and pharyngeals, i.e., for the gutturals as a class.

An additional analysis examined word-initial feature mismatches in di- and multisyllabic words to determine whether stress had any relationship with number of mismatches. For the younger age group, there were .7 mismatches (28) per child in initial unstressed syllables and 1.0/child in initial stressed syllables. The older age group showed .97 feature mismatches per child in unstressed syllables and 1.8 in stressed syllables per child. The at-risk group again had notably more mismatches, with 3.1 mismatches per child for unstressed syllables and 6.1 for stressed syllables. Overall, there were relatively more mismatches in onset to stressed syllables, but differences were small.

3.6 Consonant Sequence Acquisition: Mismatch Analysis

This section will present results from the consonant sequence mismatch analysis. It will look at the three groups of children in the same way as the previous section, and will subdivide the data into word-initial, word-medial, and word-final positions, with a final summary at the end of the three main sub-sections. The younger and the older age groups will be looked at together for each word position, followed by the at-risk group. Overall, there were 224 cluster mismatches, or 2.8 per child (/80). Again, throughout this section, the mismatches were quantified without respect to opportunities for various patterns, due to the vast amount of data, the low number of overall mismatch patterns, and the hand calculations. Where a target was infrequently or frequently sampled, this is indicated.

3.6.1 Word-initial Consonant Sequence Patterns—Younger and Older Groups

Tables 3.19 and 3.20 show consonant sequence mismatches for the younger and older age groups. They are examined together because of the low frequency of tokens, both for targets and mismatch patterns.

Table 3.19 Word-initial consonant sequence patterns – younger age group

Adult	C1 del	V epen (Acceptable)	Metath.	[+grvd] > [-grvd]	[-ant] > [+ant]	[trilled]> [other rhotic]		Sum
				C1	C1	C1	C2	
bj		11						11
fl		4						4
sr		29		1			1	31
sˤħ		15	3	1				19
sm		9		1				10
χʃ	1	16						17
χj		8						8
dʒd	1	15	2		1			19
Token sum	2	107	5	3	1		1	119

Note. Numbers represent both tokens and numbers of children because there was only one target per sequence (*n*=40).

Table 3.20 Word-initial consonant sequence patterns—older age group

Adult	C1 Del	V epen (Acceptable)	[+grvd] > [-grvd]	Pharyngeal .> Dor [+high]	Sum
bj		8			8
fl		12			12
sr		23	4		27
sˤħ	1	17	3	1	22
sm		13	1		14
χʃ		8			8
χj		6			6
dʒd	2	20			22
Sum	3	107	8	2	120

Note. Numbers represent both tokens and numbers of children (*n*=32).

Overall, for the younger age group, there were 119 mismatches or 2.97/child, whereas in the older age group there were 120 mismatches, or approximately 3.7 per child, i.e., a slightly greater number. The consonant sequences in word-initial position underwent infrequent

consonant deletion (cluster reduction): for the initial consonant, two tokens for the younger age group, three tokens for the older. See examples below:

خشوم	/χʃuːm/	[ʃuːm]	/χʃ/ → [ʃ]	*noses*
جدور	/dʒduːr/	[duːr]	/dʒd/ → [d]	*pots*

Acceptable vowel epenthesis was relatively frequent among these two groups (107 tokens per group). That means 2.7 acceptable vowel epenthesis per child in the younger age group, and 3.34 for the older age group overall (although only 32/40 children did this in the younger group, and 20/32 in the older, and as shown earlier, these differences were not statistically significant). See examples below:

صحون	/sˤħuːn/	[sˤɔħuːn]	/sˤħ/ → [sˤɔħ]	*plate* (unacceptable vowel type)
سرير	/sriːr/	[səriːr]	/sr/ → [sər]	*bed* (acceptable variant of *bed*).

These clusters also showed mismatch patterns reflecting patterns for singleton consonants. Grooved fricatives were degrooved within these clusters in the same way they were in the single consonants. The older age group appear to have degrooved more than the younger age group, as the following example will show:

سرير	/sriːr/	[s̪riːr]	/sr/ → [s̪]	*bed*
صحون	/sˤħuːn/	[s̪ˤħuːn]	/sˤħ/→ [s̪ˤħ]	*plates*

The younger age group also showed metathesis, while the older age group had none.

صحون	/ʔəsˤħuːn/	[ʔəħsˤuːn]	/sˤħ/ → [ħsˤ]	*plates*

For both younger and older groups the following sequences showed the least vowel epenthesis: /bj/, /χj/, /fl/, /sm/. These three showed the most frequent vowel epenthesis: /sr/, /sˤħ/, /dʒd/.

3.6.2 Word-initial Consonant Sequence Patterns—At-Risk Group

Table 3.21 shows proportion of children with word-initial consonant sequence patterns for the at-risk group.

Table 3.21 Word-initial consonant sequence patterns—at-risk group

Target	C del		V epen	Meta.	[+cont] > [-cont]		[+grvd] > [-grvd]		Uvular > glottal [h]	[+trill]> [other rhotic]	[+trill] > [+lat]	Sum
	C1	C2			C1	C2	C1	C2	C1	C2	C2	
bj			2									2
fl			3									3
sr			7		1		1	3		1	2	15
sˤħ			5	1	1	1						8
sm			2									2
χʃ		1	2	1	1				1		1	7
χj												
dʒd	1		2		1							4
Sum	1	1	23	2	4	1	1	3	1	1	3	41

Note. All vowel epenthesis acceptable.

The mismatch patterns for the at-risk group were more or less the same, but with more frequency. Overall, there were 41 mismatches, or approximately five per child. Acceptable vowel epenthesis was relatively high for this group (2.9/child), and there was more stopping for the initial consonant in the sequence than for the other groups. Another not unexpected

issue was the degrooving of the initial fricative in the sequence. The at risk-group did show some metathesis in /sˤħ/ and/χʃ/ with one token compared to three tokens for the sequence.

جدور	/dʒduːr/	[dʒruːd]	/dʒd/ → [dʒr]	*pots*
خشوم	/χʃuːm/	[ʃχuːm]	/χʃ/ → [ʃχ]	*noses*

3.6.3 Word-medial Consonant Sequences—Younger and Older Groups

This section examines the word-medial consonant sequences (clusters) for the older and younger age groups (Tables 3.22 and 3.23).

Table 3.22 Medial consonant sequence mismatch structural patterns—younger age group

Adult	Syl del	C1 del	C2 del	V epen	C2 > C:	Sum
mkʰ	1			1	1	3
ft					1	1
ʃd		5				5
ʁs		2	1			3
rn		1				1
rt	1	3				4
Sum	2	11	1	1	2	17

Table 3.23 Medial consonant sequence structural patterns—older age group

Adult	C1 del	C2 del	Metathesis	Sum
dr		1		1
ʃd	3	1		4
sn			2	2
rn	2			2
rt	5			5
Sum	10	2	2	14

Overall, for the younger age group there were 17 structural (out of a total of 52 sequence mismatches), i.e., .43 mismatches per child for structure and 1.2 for all mismatches. The older age group had 14 structural mismatches, .43 per child, i.e., the same as the younger group proportionately. The older group had a total of 44 mismatches, i.e., 1.4 per child.

For the individual sequences the following was noted. The younger age results showed five tokens of initial consonant deletion in the sound sequence /ʃd/ compared to three tokens for the older age group. There was only one token for the second consonant deletion in the younger age group and two for the older group. See the example below:

دشداشة /dɪʃˈdaːʃə/ [dɪˈdaːʃə] /ʃd/→[d] *men's Arabic dress*

The sound sequence /ʁs/ underwent cluster reduction in the younger age group only, where two tokens were observed. In the same way, the sound sequence /rn/ had initial consonant deletion of one token for the younger age group compared with two tokens for the older one. Similarly, the sequence /rt/ presented three tokens of initial consonant deletion for a sample total of 40 participants, whereas the older age group presented five tokens of initial consonant deletion for a total sample of 32 participants.

In terms of feature changes within medial consonant sequences, the same kinds of mismatch patterns showed up as for singletons. These included: stopping of fricatives /ʁ/ and /f/ (C1 of the internal sequence) and /ʃ/ of C2; degrooving of sibilants (three each for both age groups as in examples below), fronting of fricatives (once), backing to [Pharyngeal] for /ʃ/ (once), devoicing of /b/ and /r/ as C2, and changes in /r/ to other rhotics or glides.

مغسلة /məʁˈsələ/ [məʁˈs̪ələ] /ʁs/→ [ʁs̪] *sink*

مغسلة /məʁˈsələ/ [məgˈsələ] /ʁs/→[gs] *sink*

3.6.4 Word-medial Consonant Clusters—At-Risk Group

Overall, there were 37 mismatches, or approximately 4.6 per child in total, with 5 structural mismatches (less than one per child). (See Table 3.24 for structural mismatches.)

Table 3.24 Medial consonant sequence structural patterns—at-risk group

Adult	C1 del	V epen	Metathesis	Coalescence	Sum
$t^{ʕ}r$				1	1
mk^{h}	1				1
ʃd	1				1
fʃ			1		1
rt	1				1
rs	3		1	1	5
Sum	6		2	2	10

In contrast to the other groups, this group showed one token only of initial consonant deletion in the sound sequence /ʃd/. Similar to the other groups, the sound sequence /rt/ had one token of initial consonant deletion out of a sample of eight participants. This age group reported three tokens of degrooving of the second consonant, the same as the other two groups. Unlike the other groups, this group reflected one token of stopping for the initial consonant in the /fʃ/ sound sequence. At the same time the second consonant was fronted twice.

3.6.5 Word-final Consonant Clusters—Younger and Older Groups

This section will discuss the word-final sound sequence mismatch patterns. No tables are presented due to the low frequency of patterns. Overall, for the younger age group there were

eight mismatches, or 0.2 per child, whereas for the older age group there were four mismatches, or 0.125 per child. Word-final sequences were infrequently targeted and thus had fewer mismatches than other positions. The sound sequence /rd/ had one token of vowel epenthesis and another token of second consonant devoicing. Interestingly, three tokens were observed of the trilled /r/ changing into flapped or tapped for the younger age group, while nothing was reported for the older age group for that sound sequence. The sound sequence /lb/ had its second consonant devoice (two tokens in the younger age group, and one in the older one). The sound sequence /ldʒ/ showed three tokens of degrooving for the second consonant.

حلج	/ħaldʒ/	[ħalḍ]	/dʒ/ → [ḍ]	*mouth*
		[ħalg]	/dʒ/ → [g]	*mouth*

Equally interesting was the sound sequence /ltʃ/; one token of degrooving was reported for the second consonant in the younger age group, and one token of fronting for the older age group for the same consonant, as below:

علج	/ʕɛltʃ/	[ʕɛlts]	/tʃ/→ [ts]	*gum*

3.6.6 Word-final Consonant Clusters—At-Risk Group

Overall, there were eight mismatches, or one per child. The at-risk group reported three tokens of backing for the first consonant /r/ ([+anterior] > [-anterior]) for /rd/. See examples below:

برد	/bərd/	[bəɻd]	/rd/ → [ɻd]	*cold*

برد /bərd/ [bəɹd] /rd/→ [ɹd] *cold*

Compared with the older age group, this group, for /ldʒ/, had one token of the second consonant devoicing, one token of degrooving, and one of initial consonant deletion, as in:

حلج /ħaldʒ/ [ħalḍ] /ldʒ/ → [lḍ] *mouth*

Unlike the other groups, this group had no errors for /lb/ accept devoicing of the second consonant in the sequence. Examples for both sections are below:

كلب /tʃɛlb/ [tʃɛlḅ] /b/ → [ḅ] *dog*

The /ltʃ/ has one token of second consonant degrooving similar to the rest of the groups.

3.6.7 Summary of Consonant Sequences across Groups

Table 3.25 and 3.26 summarize consonant sequence mismatch patterns across groups, and gives the average number per child per group by word position. Table 3.25 considers all mismatch tokens. Table 3.26 shows only unacceptable word-initial patterns.

Table 3.25 Summary of consonant sequence patterns by group for all mismatches

Group	Word-initial		Word-medial		Word-final	
	Total	Avg/child	Total	Avg/child	Total	Avg/child
Younger	119	2.9	17	.43	8	0.2
Older	120	3.8	14	.53	4	0.1
At-risk	41	5.1	10	1.25	8	1

Table 3.26 Summary of consonant sequence true mismatches by group for word-initial position

Group	Word-initial	
	Total	Avg/child
Younger	12	.3
Older	13	.41
At-risk	18	2.25

In summary, the three groups reflected a variety of averages across word positions in the acquisition of consonant sequences. In both tables, it can be seen that the at-risk group had a higher proportion of sequence mismatches, whether acceptable or unacceptable. Both younger and older age groups showed approximately the same average of patterns per child in the word-initial consonant sequence. The at-risk group also reported significantly higher proportions of mismatches in the word-medial and -final consonant sequences patterns than the other two groups. These mismatch patterns conform to other results reported for this at-risk group.

The younger age group had a lower proportion of acceptable variants word initially than the older group, but referring to Tables 3.1 and 3.2, it is noted that only 20/32 children did acceptable epenthesis word initially in the older group (66.7%) whereas 32/40 (80%) of the younger children did. The difference was not statistically significant but the trend shows that the older group is showing less of this pattern across children, even if not across tokens.

For specific sequences, /sm/ had only one token of degrooving in both the older and the younger age groups, with also one for /sˤħ/ in the younger age group plus two tokens for the sequence /dʒd/. (No metathesis was reported for the older age group, in contrast to the younger group.) The older age group had four tokens of degrooving in the sound sequence /sr/, compared to one token for each of the other two groups for the same sequence. The sound sequence /sˤħ/ had no degrooving examples in the at-risk group, but there were three tokens of degrooving in the older age group, and one token only in the younger group.

4 DISCUSSION

The purpose of this thesis has been to describe the phonological development patterns of Kuwaiti Arabic-speaking 4-year-old children as a step toward development of a test of phonological acquisition for Kuwaiti Arabic. The discussion follows the presentation of results in Chapter 3, concerning: word elicitation issues, whole-word match, word lengths and word shapes; then consonants and their manner, laryngeal and place features; and finally consonant sequences.

In the present study 80 monolingual preschoolers were tested and digitally audio-recorded using a (primarily spontaneous) single-word picture-naming task. For most of the analyses, the speech samples were divided into three groups: (1) a younger group (40 children: age range 46-54 months; mean age, 50.03 months), (2) An older group (32 children: age range 55-62 months; mean age, 57 months), (3) and a group at risk for protracted phonological development (8 children: age range 49-62 months; mean age, 54.75 months).

The study addressed the following issues (questions at end of Chapter 1), which are discussed in turn in the next section.

1. What 4-year-old Kuwaiti children are capable of in terms of speech/phonological production (inventory) for:

   1a. Word structure: word lengths and word shapes

   1b. Consonants and Manner, Laryngeal and Place features

   1c. Consonant clusters.
2. What developmental patterns and constraints appear in the speech of 4-year-old Kuwaiti children for:

2a. Word structure

2b. Consonants and their features.

3. What the necessary parameters and criteria are for a phonological assessment tool for 4-year-olds, based on the results of the previous questions, i.e., expected level of mastery for the various categories identified above for the age, based on measures of central tendency for the identified variables?

4.1 What Are the Phonological Inventories of a Normally Developing 4-Year-Old-Kuwaiti Arabic-Speaking Children?

The sections below present a note on morphology, then discuss general whole word match and word structure inventories (word length, word shape, consonant clusters). The final section 4.1.4 discusses consonant inventory development. Before moving into the following section, it is worth mentioning that Arabic has a large number of dialects, which reflects the production of acceptable variants in Kuwaiti Arabic. Acceptable variants have been noted throughout.

4.1.1 Word Choice, Morphology and Phonology

As noted in the Results, some words seemed unfamiliar and these are discussed later as study limitations (section 4.5). In addition, several words showed children taking advantage of either acceptable or dialectal variants in word use or plural morphology to possibly avoid complex phonological forms, particularly word-initial clusters. The most notable patterns were acceptable epenthesis of schwa (between or in front of clusters, something that adults also do variably), use of the 'safe' plural which added a syllable and thus changed the syllabification and/or order of segments (metathesis or migration), and deletion of final

schwa to shorten words. The strategies did not always result in accurate forms, e.g., /ˈsmɪtʃə/ as [smu:tʃ] (*fish*); the [u] is sometimes found in other plurals, suggesting over-generalization, but this form had no schwa between /s/ and /m/ which is necessary for the accurate plural /ˈsɪmətʃ/. There was also some merging of forms to avoid initial clusters, i.e. [sɪmtʃə], blending the plural [sɪmətʃ], and singular [smɪtʃə]. (See further examples in Results, section 3.1.) Clearly there needs to be a detailed investigation of the interaction of word use, morphology and phonology in Kuwaiti Arabic acquisition, but that is beyond the scope of this thesis. Certainly other languages show phonological-morphological interactions in development (e.g., Bernhardt and Stemberger, 1998).

4.1.2 Whole-Word Match (WWM)

The results revealed a whole-word match (WWM) of approximately 80% over *all* children (SD, 14%) with no difference between age groups. A group of eight children was classified as a "possible at-risk" group, because they had a WWM lower than 60%, more than 1.5 standard deviations below the mean for the overall sample and two below the mean for their respective age groups. The at-risk group included five older and three younger children. However, in addition, there were two older children with low WWMs (59.8 and 61.6%) and one in the younger (61.3%), who were not included in the at-risk group because they were at the border line of the dividing criterion of 60%. Although the recruitment process called for typically developing children, it could be that schools or families referred children if there was some possible cause for concern (assumption of assessment versus research since the forms mentioned the goal of the study was to develop assessment tools for Kuwaiti Arabic).

As noted in section 3.2, children at or below 60% WWM might need to be re-evaluated to determine whether they in fact had protracted phonological development.

In comparison with children acquiring other languages, a recent study by Bernhardt, Zhao, Lai and Stemberger (2010) showed a similar WWM of approximately 80% match for a word list of equivalent complexity and length for 30 typically developing Mandarin children. Schmitt, Howard and Schmitt (1983) had similar findings for English, where children showed 80% of WWM at the age of 4 years, and 83.77% at 4.5 years of age. This suggests some possible universality of word accuracy by age and concurrent validity with other tests for the particular word list. Note that the scores might have been a little higher if slightly degrooved sibilants had not been considered mismatches, but that this would also be true of the other studies.

4.1.3 Word Structure: Word Lengths and Shapes

Previous studies on Arabic acquisition have given very little information on word lengths and shapes. The Jordanian and Egyptian Arabic papers (Ammar and Morsi, 2006; Dyson and Amayreh, 2000) for example, lacked a detailed look at word shapes, because they focused on consonants. The current study thus adds to the Arabic developmental literature in general concerning word structure.

The words in the test varied from one to four syllables and children were overall able to match word length.[2] Four-syllable words showed the fewest mismatches at all levels, including WWM, clusters, and Manner, Laryngeal and Place features. However, the fact that there were only two four-syllable words may have skewed the results in their favour (there

[2]Stress patterns were not systematically examined, due to lack of information on adult Kuwaiti Arabic stress; however, one analysis compared patterns for word-initial consonants and syllables in stressed versus unstressed syllables. In addition, where initial weak syllable was identified, this was noted throughout the examples.

were 13 trisyllabic words, for example). Word shape acquisition levels are summarized below with results compared across study groups.

In summary, 90+% of the three groups had acquired:

1. the monosyllabic word shapes CVV, CVC(C),
2. the disyllabic word shapes CV(V)CV and CVCCV and
3. the multisyllabic word shapes, CVCVCV(C).

At the 90+% criterion by subject number, the older age group had acquired, in addition, CVCCVC and remaining multisyllabic word shapes except for CVCCVCVC. The at-risk group had also acquired all multisyllabic word shapes at that criterion except for CVCVCVCV and CVCCVCVC.

None had acquired the word shapes CCVC, CVCVC, CV.VC or CVCCVCVC at the 90+% criterion. However, the older and at-risk groups showed CVCCVCVC in the 75-89% range. In addition, the older group produced CVCVC in that range, and the at-risk and younger groups, CVCCVC similarly.

Interestingly, the percentages of 90+ % for disyllabic word shape acquisition revealed similarity between both the younger and at-risk age groups. The older age group in contrast, had acquired the disyllabic word shape CVCCVC, in addition to the VC(V)CV and CVCCV word shapes, which were acquired by the other two groups as well. There was more advanced word shape acquisition in the older age group, i.e., more proficiency with words containing both sequences and codas. The word shape CVCVC, however, showed comparatively lower acquisition levels, even though it had no clusters. If only true mismatches are considered as in Tables 3.1-3.3, then 90+% of the older group had acquired this word shape, 75-89% of the younger age group, and fewer than 75% of the at-risk group.

If all differences were considered, as in Table 3.4, then only 75-90% of the older group had acquired this word shape and fewer than 75% of the other two groups. This word shape was most frequent in the word list (26.1%), which may have increased the probability of mismatches across children. (But see further discussion in 4.2.1.)

For the multisyllabic word shapes the younger age group was different from the other two groups because only the word shapes CVCVCV(C) were acquired. Unlike the younger age group, the older age group had acquired all multisyllabic word-shapes at a 90+% criterion (by number of children) except CVCCVCVC, which was difficult for children because of the cluster and the coda. The at-risk group was between the other groups, showing acquisition of all multisyllabic word shapes except CVCCVCVC (showing similarity to the older age group) and CVCVCVCV. It is noticeable that the at-risk group demonstrated similarities to the younger age group in the acquisition of the disyllabic word shapes on the one hand and to the older age group in the acquisition of the multisyllabic word shapes on the other. Because they were drawn from both age groups, they may therefore have had characteristics of both. However, what is important to note overall, is that their word structure was relatively good compared with their consonant acquisition. This is to say that they may or may not show protracted development later (see also 4.2.1). The most common constraints (high-ranked) and repair processes are presented in 4.1.2 as further discussion on the word structure inventories.

Overall results for word shape mirror results of studies of English (Ferguson, 1978; Smit, 2007; Stoel-Gammon and Dunn, 1985); that is, codas were acquired after open syllables, and consonant sequences appeared later than singletons. Since Arabic and English overlap in their word shape types, word shape acquisition could be predicted to be somewhat similar as

found in this study. In terms of what was acquired, the monosyllabic word shapes CVV and CVC(C) were acquired at the 90+% criterion, also acquired by age 4 in English (Smit, 2007). The disyllabic word shapes CV(V)CV and CVCCV(C) were acquired by at least 76% of children across groups, showing similarity with acquisition of medial position in English (Smit, 2007). The later acquisition of CVCVC in this sample may be different from English (Stoel-Gammon, 1987), where 2-year-olds were reported to have acquired this word shape (but see section 4.2.1 for further discussion). Some multisyllabic shapes were also acquired but others with both codas and clusters were not. This again reflects acquisition in English regarding multisyllabic word acquisition (James, 2006). Another unacquired monosyllabic word shape for the 4-year-olds was CCVC, because of the word-initial cluster; this is also true for English (see below). The disyllabic word shape CVCCVC was challenging, probably because of the added complexity of a final coda plus medial cluster. Nothing is known for English about this word shape.

Further to consonant sequences comparing English and Kuwaiti Arabic acquisition, according to Smit et al. (1990) only word-initial /tw/ and /kw/ were acquired to a 90+% criterion by age 4. Other researchers have noted that some /s/ and /l/-clusters are acquired by 75% of children at that age (e.g., Templin, 1957). The difficulty in acquiring consonant clusters arises from the fact that these are sound sequences with two or more places and/or manners and/ or laryngeal features. In the current study, all of the word-initial clusters were acquired by at least some children across groups. A 90+% criterion was reached for only one cluster (and only in the younger age group), i.e., for /fl/ in /flu:s/ (*money*), a word frequently spoken to children; this cluster also has the early-acquired labiodental /f/ and the relatively early-acquired /l/. Across groups, /χj/ was acquired by at least 75% of children, in spite of the

fact that the singleton /χ/ was not acquired to the 90+% criterion except by the older group. The success with the cluster may reflect the fact that the word /χjut/ (*threads*) was a word often elicited with direct imitation in the study. Others that showed 75-89% acquisition were /bj/, /sm/ and /χʃ/. Again, these were frequently elicited with delayed imitation, which may have influenced output. On the other hand, both /bj/ and /sm/ had early-acquired consonants (except for /s/, which may have shown some degrooving) and the uvular cluster is similar to the other one that showed few mismatches (χj).

There were many medial consonant sequences, all of which were produced by at least some children. Because many showed no structural changes, we only mention here the ones with less than 90+% match for structure, which would therefore not be expected for 4-year-olds: /ʃd, rt, rs/. All of these contained consonants that were later-developing consonants as singletons. For word-final position the following were acquired in terms of structure, i.e., /rd, lb, ldʒ, jl, ltʃ/, although some children showed feature mismatches (see section 4.2.3). To date there have been no specific studies of acquisition of Kuwaiti or standard Arabic consonant clusters; however, Dyson and Amayreh (2000) observed that word-medial consonant clusters were not yet acquired between 4;0 and 4;4. For English, no information is available on word-medial clusters (Templin, 1957; Smit et al., 1990; Stoel-Gammon, 1987). Further research on cluster development is needed.

To summarize, Kuwaiti 4-year-olds were capable of producing words as long as four syllables with a variety of word structures. Words with syllable-initial clusters were not yet acquired across children, and words with both codas and clusters were particularly challenging.

4.1.4 Consonant Inventory and Manner, Laryngeal and Place Features

Before discussing the results of the current study, the predictions for consonant development are reviewed based on previous work in Jordanian Arabic. According to Amayreh and Dyson (1998) early consonants (before the age of four) in Jordanian Arabic consist of four non-emphatic stops /b/, /t/, /d/, and /k/; two non-emphatic fricatives /f/ and /ħ/; nasals /m/ and /n/; and approximants /l/ and /w/. These segments exhibit the Manner features [+consonantal], [-continuant], [+continuant], [-sonorant], [+sonorant], [+lateral], and [+nasal], the Laryngeal features [+spread glottis], [-spread glottis], [+voiced] and [-voiced]; and the Place features [Labial], [Coronal +anterior], [Dorsal], and [Pharyngeal] (only/ħ/). However not all feature combinations are present, i.e., with [Dorsal] (no uvulars), [Pharyngeal] (missing /h, ʕ/), [+sonorant] (no trilled/r/) or [+continuant] (not all fricatives). Between the ages of four and six, according to Amayreh and Dyson, the inventory also includes the coronal fricatives /s/ and /ʃ/, uvular fricatives /χ/ and /ʁ/ and [Pharyngeal/Glottal] /h/. The trilled /r/ also appears at this intermediate stage.

Because children in the current study were over 4;0 years of age, it was expected that they would show both the early and at least some of the intermediate phase consonants as described by Amayreh and Dyson (1998). Intermediate phase features would mean increased

use of the Manner feature combination [+continuant], [-sonorant] (fricatives) and Laryngeal features [+spread glottis], and the addition of the Place features Coronal [+grooved] and [-anterior], plus more feature combinations with [Dorsal] and [Pharyngeal]. I return to this set of preditions after a brief recapitulation of findings.

Comparing the consonant inventory of the study groups, in order to investigate what was established and what was not, we see the following situation. Acquired by 90+% of children in the younger and older age groups where the following (the at-risk group is not included here because of their greater degree of mismatch for segments):

1. Stops /b, bː, t, d, tˤ, tːˤʰ, k, g, qː, ʔ/ (i.e., across laryngeal and place features)
2. Sonorants /m, n/, /w, j(ː)/ and /rː/ (i.e., nasals, glides and long /rː/)
3. Fricatives /f, ðˤ, ʃ, ħ, h, tʃ/ (all places except uvular but not including all combinations, and only one voiced fricative).

The younger age group had acquired the same fricatives as the older group but also /sˤ/ and /χː/. Fricatives acquired by the older age group also included /χ/ (but not the long /χː/, and the voiced uvular /ʁ/).

Although the at-risk group produced tokens of a variety of segments, it did not produce many of them to the level where they could be called established (90+%). Interestingly, the stops /bː, qː, ʔ/, nasals /m, n/, fricative /f/, and glides /w, j, jː/ were acquired by 100% of this group; other segments at 87.5% acquisition were /l/, the fricatives /f, χː, ʁ, h/ and velar stops. The at-risk group, e.g., had acquired the stops /t, d, tˤː/ only at the 75-89% level.

Compared with the other Arabic findings discussed in the literature review, most of the Kuwaiti children showed a more advanced consonant inventory at an earlier age than children speaking Egyptian or Jordanian Arabic. The Kuwaiti Arabic speakers had acquired much of their consonant inventory before age 5 years (Dyson and Amayreh, 1998). For the two age groups, the only features left to acquire were: [+ trilled], [+ grooved] and [-grooved]. The feature [Pharyngeal] was fairly well-established, although certain feature combinations with [+continuant] remained challenging, i.e. [+ voiced, + continuant, -sonorant]: /ʕ, z, ʤ/. In terms of the at-risk group, their segmental inventory resembled the early inventory as described by Amayreh and Dyson (1998) but with some differences: (1) lack of coronal stop acquisition in the current study and (2) appearance of later fricatives /χː, ʁ/. This type of possible 'chronological mismatch' (i.e., having some usually later-acquired forms while not showing typically forms) has been reported by Grunwell (1985) as sometimes typical of children with protracted development. It is difficult to compare the current results with English segmental acquisition, because the English studies have many disagreements as to level of mastery and age of acquisition (see Table 1.2; also Smit, 2007). However, the later acquisition of grooved consonants and /r/ as is found here is similar to many of the English studies.

4.2 What Developmental Patterns and Constraints Appear in the Speech of 4-Year-Old-Kuwaiti Children?

4.2.1 Word Structure

The Kuwaiti Arabic-speaking preschoolers reflected some developmental patterns that conform to the phonology of other languages. Consonant and vowel addition and deletion, as

well as syllable deletion were reported. Consonant and vowel lengthening or shortening were relatively infrequent, with vowel epenthesis (acceptable) fairly frequent as a way to break up consonant sequences word initially. Final vowel deletions were usually acceptable variants, and often reflected use of plural instead of singular. Results from a paired *t*-test showed that all deletions by word shapes were fewer in the older age group. This reflects developmental progress across the age range within the sample. Although the older group showed fewer children with vowel epenthesis, no significant differences were found for proportion of vowel epenthesis between the two age groups.

One analysis specifically examined interaction of stress and deletion in word-initial position. There were more instances of syllable deletion in the unstressed syllable (particularly for the younger and at-risk children, but these differences only approached significance [p=.058], probably due to the low numbers).

In summary, although mismatches were generally low in frequency overall, where they occurred they showed the following high-ranked constraints resulting in deletion or epenthesis.

1. NotComplex: Avoidance of consonant sequences, particularly word initially, through vowel epenthesis (often acceptable), consonant deletion or even syllable deletion
2. NotProminent(Right) leading to deletion of weak initial syllables.
3. Not(Coda): This was generally low-ranked but sometimes emerged in internal codas such as in CVCCVC and in long words.
4. Syllable>Onset: Another interesting pattern occurred for CV.VC, where a variety of patterns were used to account for the vowel sequence (riˈuːl *fee*). This suggested a

high-ranked constraint against two vowels in sequence in different syllables, i.e., the requirement that all syllables have an onset.

Regarding patterns (repair processes as noted above), morphological changes (plural use) sometimes allowed avoidance of some complexities found in other forms (singulars). Using the plural where a final syllable was deleted made it easier for the chidren to attempt long target words. The safe plural (an addition of a syllable) sometimes allowed avoidance of consonant sequences by changing segment order. Thus, morphological changes or over-generalizations accommodated phonological constraints (see section 3.1). Acceptable vowel epenthesis was used by all children at least once in sequences.

One unexpected finding was that a word shape acquired by English learners by age 2 (CVCVC) was not fully acquired by the 4-year-olds. In addition to mismatches involving consonant or vowel deletion or consonant epenthesis, there was also acceptable syllable deletion and epenthesis for this word shape. Some of the acceptable vowel deletions resulted in word-initial consonant clusters. This is worthy of note because acceptable vowel epenthesis was observed in many word-initial target clusters; this represents an apparent conflict in constraint ranking concerning the two word shapes CCVC and CVCVC. On the one hand, clusters were disallowed and vowels inserted (CCVC > CVCVC); on the other hand, a vowel was deleted, resulting in a cluster (CVCVC > CCVC).

CCVC: NotComplex(Onset) >> Not(Vowel) (allows vowel epenthesis)

CVCVC: Not(Vowel) >> NotComplex(Onset) (requires vowel deletion)

The adult language has variable use of word-initial sequences and undoubtedly the children were reflecting this flexibility in onset production.

Dyson and Amayreh (2000) and Ammar and Morsi (2006) for Jordanian and Egyptian Arabic noted low frequency (5-10% of children) of structural patterns such as syllable and coda deletion but a higher proportion of sequence simplification. The results of the current study were similar in proportion of patterns, but also discuss other frequent patterns such as epenthesis in clusters (acceptable and non-acceptable) and metathesis (low frequency also). The results show some similarities with English word shape acquisition; for example, Grunwell (1985) found final consonant deletion and consonant reduction up to age 3 years, with cluster reduction becoming more limited after that age, something found also in the current study. Initial weak syllable deletion is also reported often for English, even for older children in multisyllabic words (James, 2006). One difference between English and Kuwaiti Arabic acquisition involves epenthesis to break up word-initial clusters. This has been reported as an infrequent pattern for English (Chin and Dinnsen, 1992). Kuwaiti Arabic speaking adults tend to use epenthesis in their production of clusters; thus, the children appear to be reflecting that input.

Note that for consonant sequences in word-medial and word–final positions, very few structural changes were noted (deletion or epenthesis), but there were a few instances of devoicing, degrooving, or /r/ changes, reflecting the segmental inventory.

4.2.2 Consonant Mismatches by Feature Type

Predictions: Following Dyson and Amayreh (2000) for Jordanian Arabic, the following mismatch patterns would be expected for Kuwaiti Arabic.

Manner

1. Use of [l] for /r/, i.e., [+trilled] > [+lateral] (Manner—common);

2. Stopping of fricatives and affricates, i.e., [+continuant, -sonorant] > [-continuant] (Manner—less expected);
3. Spirantization (stop > fricative) between vowels, i.e., [-continuant] > [+continuant] (Manner—less expected).

Place

1. Degrooving ([+grooved] > [-grooved]): children would omit grooved consonants or substitute a non-grooved consonant, with a gradual decrease over the 5th year;
2. Fronting of velar and uvular stops might be expected even while children produced accurate uvular fricatives;
3. Glottal stop replacement;
4. Loss of the secondary 'emphatic' or 'pharyngealized' articulation (Manner and Place—common).

This study generally conformed to the previous findings from Dyson and Amayreh (2000), except for the earlier acquisition of the emphatic sounds. The findings reveal the following when comparing the three groups in terms of Manner features. The younger age group showed 118 total mismatches for the 40 children (2.95/child) with equivalent mismatch rates across word position. The older age group showed 61 total mismatches for 32 children (1.9/child). In contrast, the at-risk group showed 100 mismatches for the eight children (12.5/child). The highest proportion of mismatches was in the at-risk group. Results are discussed below in terms of the predictions.

Manner

1. Changes for /r/: Overall the highest number of mismatches was for trilled /r/. There was a great variety of mismatches: [ɹ], fricatives [ʁ] and [β], glides [w], [ʊ], [j] and

[ɯ], and lateral [l]. This differed from Amayreh and Dyson (1998), who had several small age groups and lower number of targets; they reported only [l] for /r/.

2. Stopping: Next highest in number of mismatches were /ð/ and /dʒ/ (seven mismatches), similar to Amayreh. In addition, /θ/ had five mismatches across word positions of the same type as /ð/ ([t] and [d]).

3. Spirantization: Although stops rarely surfaced as fricatives, the affricate /dʒ/ had nine mismatches across word-initial and word-medial positions in the younger group. These mismatches consisted of spirantization of the affricate [-continuant]-[+continuant] > [+continuant].

Comparing the two age groups, the younger age group showed the higher number of mismatches (average of 2.9/child). Stopping and spirantization were common manner mismatches for that group. Nasalization and denasalization were less frequent than the rest of mismatches. The highest proportion of manner mismatches was for /r/: all types of mismatches were present such as [-trilled] ([ɹ]), [-continuant, -sonorant] (fricative) and [+lateral] ([l]), with and without [+retroflex] (see Table 3.18). The older age group had two-thirds of the number of mismatches reported for the younger age group (1.9/child). Types of mismatches were similar: stopping, spirantization, and /r/ changes such as substitution of [- sonorant], [-trilled] ([ɹ]), [-consonantal] (glides), and [+continuant, -sonorant] (fricatives).

Finally, for the at-risk group, there were 100 manner mismatches, with an average of 12.5 per child. Types of mismatches were spirantization and stopping. The highest manner

mismatch was reported for the /r/ with substitutions of [-trilled] ([ɹ]) and [+lateral] ([l]).

Overall, manner mismatches were highest for the trilled /r/ among the three groups, and other types of mismatches were the same among the group except for the variation in frequency. The younger and older groups, however, showed more variety in substitutions for the trilled /r/.

For English, after age 3, reports indicate more limited stopping (e.g., for /v/ > [b] or /ð/ > [d]), but continued gliding or vocalization of liquids (Stoel-Gammon and Dunn, 1985).

Continuing with predictions, I turn now to place.

Place

1. Degrooving ([+grooved] > [-grooved]): Frequent fronting and dentalization of the fricatives and affricates were noted, probably because children tend to have a smaller oral cavity before the eruption of the adult teeth. This was similar to the previous studies.
2. Fronting of velar and uvular stops was of very low frequency, as was fronting of uvular fricatives. This differed from Amayreh and Dyson (1998), who found fronting of the stops.
3. Glottal stop replacement was uncommon in the Kuwaiti preschoolers' sample, unlike in previous studies (e.g., Amayreh and Dyson, 1998).
4. Loss of the secondary 'emphatic' or 'pharyngealized' articulation was noted, more for the at-risk group than the two age groups, where this was an infrequent pattern, especially for the older group. Unlike the results of Dyson and Amayreh (2000), the emphatics and the secondary articulation were generally maintained by the 4-year–old

children in this study; de-emphasis was infrequent (and there was occasional use of emphatics for plain consonants).

For Place features, the findings showed that the Kuwaiti preschoolers were capable of maintaining places of speech production, but with some mismatches, particularly in certain categories ([+grooved], trilled /r/). The younger age group showed 4.5 patterns per child. This could be considered relatively high, but this group showed plenty of normal developmental patterns, such as degrooving, changes for /r/, fronting of palatoalveolars, a certain degree of de-emphasis or pharyngealization. The older age group surprisingly had a slightly higher proportion of Place mismatches than the younger (an average of 6.12/child), although with the same types of patterns. The older age group generally revealed a more advanced situation with regard to phonological acquisition, except for the feature [+grooved]. There is no obvious explanation for this observation. The highest proportion of place mismatches was reported for the at-risk group (15.76/child) who again showed the same types of patterns, but at a much higher frequency.

For English, Grunwell (1985) notes minimal fronting after age 3 and labialization of /θ/. Other authors have noted the later acquisition of coronal fricatives and affricates, with observations of degrooving (e.g., Smit, 2007) and depalatalization (Stoel-Gammon and Dunn, 1985).

Laryngeal

Turning to Laryngeal features, devoicing and voicing were apparent but not prevalent in the speech production of the children. For the younger age group there were 0.6 Laryngeal mismatches per child across word positions, compared with 0.3/child for the older age group. Therefore, it could be concluded that the older age had acquired the Laryngeal features, since

there were no significant mismatches. The at-risk group had the highest proportion of Laryngeal mismatches—2.9 per child, more than twice the proportion of mismatches of the younger age group. These findings correspond with findings for word shape acquisition, and again justify classifying this group as "at-risk" (although the proportion of mismatches is still relatively low for laryngeal features). It was observed that the older group did only partial devoicing, distinguishing them from the other groups who had full voicing or devoicing for some targets. The partial devoicing probably reflected oral-motor development in the vocal mechanism, rather than any phonological process. The phonetic outcome of immature vocal fold movement is partially devoicing.

Note that Dyson and Amayreh (2000) for Jordanian Arabic did not report specifically on voicing issues during phonological acquisition, whereas Ammar and Morsi (2006) for Cairene Egyptian Arabic did report devoicing patterns across children in their 3- to 4-year-old group. For English, Grunwell (1985) found minimal voicing issues by the age of 3 but Stoel-Gammon and Dunn (1985) report final devoicing persisting after that age.

Feature Constraints

Many of the features were acquired, with only [+trilled] and [grooved] showing high numbers of mismatches. These features appeared to show markedness constraints across all groups. The /r/ requires fine motor movement and control of airflow, and distinction between grooved and ungrooved fricatives also requires fine tongue control for differences in airflow constriction.

In addition, voiced fricatives and the voiced affricate were less well-established across groups. Again, the coordination of vocal fold movement and airflow constriction is perhaps challenging until later preschool years.

Interaction of stress and feature constraints

In an analysis of feature mismatch patterns in stressed vs. unstressed word-initial syllables, children showed a non-significant higher proportion of feature mismatches in stressed syllables. Although non-significant, this was an unexpected finding because the stressed syllable is more salient acoustically, and one would assume should therefore have a significantly lower proportion of mismatches. This finding is difficult to explain, but suggests further research in this area may be warranted.

4.2.3 Consonant Sequences

This subsection will review specific consonant sequence patterns according to their word positions. The two major patterns have been identified earlier as consonant deletion or (usually acceptable) vowel epenthesis. For all groups, consonant deletion was minimal in word-initial position, with all groups showing deletion of the affricate in /dʒd/ on occasion. The younger group showed one deletion of C1 of /χʃ/ and the at-risk group, deletion of C2, while the older group showed one deletion of C1 of /sˤħ/. Acceptable epenthesis was noted for all sequences for at least some children. The most instances of acceptable epenthesis occurred for /sr/ and /sˤħ/ across groups, for /dʒd/ for the younger and older groups, for/sm/ for the older group and for /χʃ/ for the younger group. These suggest possible manner constraints on repetition of fricatives, or sequences of affricate-stop and fricative-/r/ for at least a few children. However, in all cases, sequences included late-developing segments, which may have increased the difficulty for sequence production and resulted in patterns of deletion or epenthesis.

Word medially, there were more instances of consonant deletion in sequences, particularly the first consonant, which was usually the coda of the preceding syllable. Although deletion was still infrequent overall, the sequences showing the highest proportion of mismatch were /ʃd/ and /rt/ for the younger and older age groups, and /rs/ for the at-risk group. Again, the later-developing segments appeared to be affecting sequence production. For the word-final clusters, there were very few mismatch patterns noted but these usually involved feature changes reflecting segmental constraints.

4.3 What are the Necessary Parameters and Criteria for a Phonological Assessment Tool for 4-Year-Olds?

A functional phonological assessment tool for 4-year-olds must fall within one of the three groups as described by Kennedy (2007):

(1) norm-referenced (or standardized tests)

(2) criterion-referenced

(3) observational tools

Because the evaluation tools used in researching this dissertation are aimed at being a step toward the eventual development of a norm-referenced instrument, the following discussion is organized according to the necessary parameters or psychometric concepts according to e.g., Kennedy (2007), or McCauley and Swisher (1984). A phonological assessment aims to describe and evaluate the speech sound-production system of an individual. This can be done in two basic ways (and was done in the current study):

1. Examining the speech sound system independently of adult target ("independent analysis").

2. Comparing the person's speech with the adult pronunciations within a particular community at a particular age or ages. This procedure is called "relational analysis". This is often a procedure followed for constructing a testing instrument.

4.3.1 Reliability of Procedures

Reliability means the consistency with which a test measures what it is supposed to be measuring (Kennedy, 2007). The study aimed to test phonology through an audio-recorded picture-naming task as conducted by one person who was a native speaker of Kuwaiti Arabic; therefore, a consistent procedure was used across all children, increasing its reliability. A few lexical items were labeled differently across children, reducing reliability for those items. For example, see the discussion above on plurals. In addition, *camel* was not very reliably assessed, because some children responded with unexpected variants, i.e. different lexical items.

4.3.2 Validity

Validity means the relevance and appropriateness of the interpretations and uses of the test results. Content validity is considered relatively high because the vocabulary items for the test were selected by a native speaker of Kuwaiti Arabic who is familiar with the speech of children in Kuwait. The word list took into account the vowel and consonant inventories of Kuwaiti Arabic across word positions in order to obtain a comprehensive picture of each child's phonology. Furthermore, the word list took into account a variety of word length and stress patterns. The word shape is also an important aspect of phonological form through which word production can be measured and a variety of Arabic word shapes were included. The content in this case should be valid for all children speaking Kuwaiti Arabic.

The concurrent validity for this elicitation tool appears high, because the results of this study showed fair agreement with the Jordanian Arabic results presented in Amayreh and Dyson (1998), with some divergence possibly reflecting sample size or dialect. In general, the presence of the above-mentioned types of validity enhanced the construct validity for a phonology tool for Kuwaiti Arabic. As noted above, this tool was designed to meet all the factors of content validity such as item appropriateness, sample completion, and manner of content assessment. The pictures were carefully chosen to stimulate the children with the best available clarity and quality. The toys were looked at carefully, avoiding any poor quality materials in order to maintain health and safety specifications. All items were within the child's conceptual repertoire by age in order to minimize constraints. The word shape and the segments were within the potential age range of the intended children.

Finally, as a basis for development of a potential clinical test, the results made an at-risk group clearly identifiable; therefore, the tool has potential validity for determining both typically and atypically developing phonology, i.e., the stimulus items have discriminability. (This at-risk group would need to be tested in the future to confirm their risk status.).

4.3.3 Standardization

Because it is impossible to test everyone in a population, a normative and a representative sample from that population must be tested instead. For the present study, the sample was proportional to the demography of each school district. To maintain the characteristics needed in a representative test population as outlined by Kennedy (2007) and McCauley and Swisher (1984), participants came from a wide socioeconomic spectrum, and children from all school districts were tested. The genders were 38 males, and 42 females. The sample was divided later into two groups of children in order to compare development over time: a

younger age group (*n*=40) and an older age group *(n*=32*)*, plus an at-risk group of eight children. Data were considered separately for the groups and comparisons made, showing similarities and differences among the groups.

4.3.4 Standard Error of Measurement

Because true scores are hard to determine, there is always a chance of error; therefore, tests should report a standard error of measurement. Although this tool is not yet a normative instrument, a list of acceptable variants is provided in Chapter 2; thus, the potential for increasing confidence levels is possible.

This prospective instrument was carefully constructed to meet the necessary parameters for testing the phonological development of Kuwaiti preschoolers. Some limitations were tackled during the testing procedure, and will be discussed in detail in section 4.5.

4.4 Summary Concerning Phonological Theory

Description of Kuwaiti Arabic phonology in terms of a nonlinear phonological framework provided more information about Arabic development than has been previously available. Several levels of phonological forms could be assessed using the nonlinear phonological framework. In particular, more information about word shape and word length acquisition has been provided than previously available for any dialect of Arabic. In addition, manner, laryngeal and place features were examined following the Bernhardt and Stemberger (1998) nonlinear phonology framework as applied to Kuwaiti Arabic, a unique contribution to the Arabic acquisition literature. Using the feature framework of Bernhardt and Stemberger (1998), this will enable future comparison of Arabic acquisition with acquisition

in a variety of languages in an ongoing crosslinguistic study (Bernhardt and Stemberger, 2010).

Aside from its particular characteristics, Kuwaiti Arabic was seen to conform to many linguistic universals in its developmental patterns. There was a high degree of faithfulness (or positive, possible) constraints, that was manifested by many children having a high whole word match. In this normative study, positive (faithfulness) constraints governed most of the output. On the other hand, some structures, segments and features were not present in the output because of the markedness constraints mentioned earlier, e.g., NotComplex, Not([+trilled]), Not([+grooved]).

4.5 Limitations of the Study: Standardization, Reliability, Validity

This study would have been extended to a larger number of participants if time had permitted. Due to the frequent number of statutory holidays in Kuwait with which we were confronted during the data-collection field trip of 11 weeks, 80 children were tested instead of the planned 100, (as well as nine children from a bilingual school whose data will be retained for a later study). Rescheduled sessions resulting from student absenteeism was not possible, especially because I had left my young children and husband in Vancouver for three months.

The collection of a representative and unbiased sample is an important part of collecting accurate data; this being the case, it was important to collect data from students in all six of Kuwait's school districts. At the beginning of the field trip, proportional numbers were selected for Al-Jahra and Al-Asima (Capital) school districts. At a later stage, however, this consistency was lost, for the reasons of absenteeism and regular statuary holidays noted above. The reference norms presented in the results were specific to this elicitation; any test

developed will help children in the state of Kuwait only and not in other Arabic-speaking countries.

Test reliability is the consistency of a test under repeated measures. Concerns about test-retest reliability are to be added to the limitations. The author was able to test the children only once. (However, some children needed to be tested in two sessions due to equipment issues, and they showed the same type of responses within a week or two.) Further data collection should be done in the future by a trained researcher in the discipline. There is a high demand for trained research assistants in the field of speech-language pathology. Data transcription into the International Phonetic Alphabet (IPA) was a very lengthy procedure, because the author was the only trained Kuwaiti Arabic speaker. The lack of trained transcribers added to the limitations of the study. One of the future goals to be targeted is to train Kuwaiti SLPs how to use phonetic transcription for research purposes.

The elicitation tool appears to have several parameters of validity for Kuwaiti Arabic, because it was relevant and appropriate for interpreting the phonological development of Kuwaiti Arabic-speaking children. The picture-naming tasks targeted the phonology of Kuwaiti Arabic, and the content was valid for that purpose, clinically and theoretically. Some flawed test items shall be reviewed for better content validity, however, because they were less successful at eliciting intended responses: /gfaːʃ / *spoons*, /beˈʕiːr/ *camel*, /χʃuːm/ *noses*, /maˈsːˤəsˤ/ *straws*.

Morphophonemic alternations were not the focus of the study, but they appeared to have been affected by constraints in the phonological production of some children, where alternations were still developing. This resulted in avoidance of some potential consonant sequences. For example, the plural form of the word *spoons* /gfaːʃ/ had to be removed

because most children used a different form. Children who nevertheless produced the plural form overgeneralized the acquisition of the 'safe plural' in preference to the 'broken plural' (plural forms of Arabic). The safe plural involves adding the suffix /ət/, and was preferred especially for the single form /ˈgəfʃə/ which was produced /ˈgəfʃət/ instead of /gfaːʃ/ but also for the plurals of *nose* /χʃuːm/ where they preferred to say /χəʃmət/ (*cf.* the singular form /ˈχaʃəm/). The easiest form of plural used by some children was a form in which the suffix -/ə/ was deleted, e.g., /moːzə/ > /moːz/; this was seen in, e.g., the words for *bananas* and *oranges* although this had nothing to do with consonant sequences and may have reflected input in which fruit words are often used in the plural form.

Another limitation to the study was the word list in terms of word length variety. There were only two four-syllable words and 13 three-syllable words, as opposed to the 23 monosyllabic and 50 disyllabic words (although these proportions reflect Kuwaiti Arabic). For future, the word list needs to be amended, as do many of the pictures. Pictures were either open media, taken from websites, for which copyrights were unneeded and unavailable, or were photographs taken by the author. The quality of the pictures may need to be improved for better word elicitation. A computerized version of the test may be considered.

4.6 Future Research

This study is a pioneering one, and it should be expanded to incorporate other aspects of speech and language acquisition. There is a lot more to say about these questions from the perspective of acoustics and about acquisition of vowels, morphophonemic alternations,

stress, and suprasegmentals. More data need to be gathered to develop speech and language tests for children across ages.

The State of Kuwait has faced many challenges, especially in education. Since 1991, (post–liberation), a large number of foreign private schools were established in the country, and knowledge of English expanded rapidly as many parents enrolled their children in American or English Schools. In the late 1990s the trend moved in the direction of bilingual schools and preschools. Therefore, English-Arabic bilingual preschoolers and school-aged children must be included in future studies. Moreover, the Ministry of Education imposed Arabic and Islamic studies curricula on these private non-Arabic-language schools by way of unifying the Arabic offered in the schools. This may affect the use of Standard and Kuwaiti Arabic in the future.

4.7 Clinical Implications

The profession of speech-language pathology is still developing not only in Kuwait but also in the Middle East generally. The State of Kuwait lacks standardized speech/language tests. The speech-language pathology program at Kuwait University is offered in English; speech-language pathologists being educated in English need assessment tools for working with children speaking a language (Arabic) in which the clinician's knowledge may be lacking; therefore the need for a formal assessment tool is very high. Speech tests have to accommodate the environment and the culture. The test should be described from what is known for both the child and the clinician. For example the state of Kuwait does not have a railway; therefore one or two of the children could not identify the train on the test for this study. Similarly, the wild animals and birds in North America would not help in testing the Kuwaiti children. For example, CAPES (2001) starts with a picture of a "pig"; the Kuwaiti

children are not used to seeing pigs. This study begins the process of establishing a specific test for Kuwaiti Arabic phonological acquisition. The procedures for this study were sufficiently reliable and valid for the children in the State of Kuwait, as discussed in section 4.5 above. With the use of the planned test, effective speech assessment will be possible for Kuwaiti Arabic-speaking children in the future.

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