Early Phonological Acquisition by Kuwaiti Arabic Children

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Abstract

This is the first exploration of typical phonological development in the speech of children acquiring Kuwaiti-Arabic (KA) before the age of 4;0. In many of the word's languages, salient aspects of the ambient language have been shown to influence the child's initial progress in language acquisition (Vihman, 1996, 2014); however, studies of phonological development of Arabic lack adequate information on the extent of the influence of factors such as frequency of occurrence of certain features and their phonological salience on the early stages of speech acquisition. A cross-sectional study design was adapted in this thesis to explore the speech of 70 typically developing children. The children were sampled from the Arabic-speaking Kuwaiti population; the children were aged 1;4 and 3;7 and gender-balanced. Spontaneous speech samples were obtained from audio and video recordings of the children while interacting with their parent for 30-minutes. The production accuracy of KA consonants was examined to explore the influence of type and token frequencies on order of consonant acquisition and the development of error patterns. The sonority index was also used to predict the order of consonant acquisition cross-linguistically. The findings were then compared with those of other dialects of Arabic to identify within-language variability and with studies on English to address cross-linguistic differences between Arabic and English early phonological development.

The results are partially consistent with accounts that argue for a significant role of input frequency in determining rate and order of consonant acquisition within a language. The development of KA error patterns also shows relative sensitivity to consonant frequency. The sonority index does not always help in the prediction of all Arabic consonants, and the developmental error patterns and early word structures in Arabic and English are significantly distinct. The outcomes of this study provide essential knowledge about typical Arabic phonological development and the first step towards building a standardised phonological test for Arabic speaking children.

Acknowledgements

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List of Abbreviations and Symbols

[ ]	Boundaries of phonetic form
/ /	Boundaries of phonological form
{ }	Phonological Feature
→	Realised as […]
>	More than or before
μ	Mora
σ	Syllable
C	Consonant
CA	Classical Arabic
CC	Consonant Cluster
CDS	Child Directed Speech
CHILDES	Child Language Data Exchange System
Co	Coda
E	Early
EA	Egyptian Arabic
ESA	Educated Spoken Arabic
F	Foot
GDP	Gross Domestic Product
I	Intermediate
IPA	International Phonetic Alphabet
JA	Jordanian Arabic
KA	Kuwaiti Arabic
L	Late
MKA	Modern Kuwaiti Arabic
MLU	Mean Length Utterance
MS	Morphological Syllable
MSA	Modern Standard Arabic
Nu	Nucleus
On	Onset
OT	Optimality Theory
PCC	Percentage Correct Consonant

PrWd	Prosodic Word
S	Strong syllable
SCWF	Syllable Coda Word Final
SCWW	Syllable Coda Within Word
SD	Syllable Deletion
SES	Socio-Economic Status
SIWI	Syllable Initial Word Initial
SIWW	Syllable Initial Within Word
SPE	*The Sound Pattern of English*
UG	Universal Grammar
V	Vowel
VE	Very Early
w	Weak syllable
WSD	Weak Syllable Deletion

Introduction

The study of phonological acquisition significantly assists speech and language therapists who work with children to identify and treat children with communication disorders. Normative data is required to enable researchers to develop relevant assessment tools for speech and language and to help clinicians tailor intervention plans around the child's needs. The process of early identification and intervention of children with phonological disorders is informed by the findings of developmental studies.

Extensive research on the acquisition of child phonology has been carried out in many languages, especially in English. However, research regarding the spoken form of Arabic is considerably limited. This is unexpected given that Arabic is the third most spoken language in the world after English and French. Modern Standard Arabic (MSA hereafter) is the liturgical language of over a billion Muslims around the world and is the native language of over 200 million people residing in the Arab World (Gordon & Grimes, 2005). As will be reviewed in Chapter 3 of this thesis, the variety of spoken Arabic differs from its written form, which is MSA. Arabic has perplexing characteristics and a variety of dialects that are worthy of investigation.

Phonological development in Kuwaiti Arabic-speaking children is worth studying for the following reasons:

    a. There is limited information on the phonological acquisition of young Kuwaiti children. Specifically, there are only three small-scale published studies on the typical development of Arabic phonology in young children before the age of 4;0. Therefore, a study of phonological acquisition in young children will contribute considerably to the research pool of speech and language development of Arabic-speaking children.

    b. Phonological development has been thoroughly studied in many other languages, however, only few dialects of Arabic have been explored to date. Given the diversity of Arabic dialects, it is important to explore the

Kuwaiti dialect of Arabic in order to add to the developmental knowledge base of Arabic language as a whole.

c. Speech therapists working with children in Kuwait have very limited information on which to base phonological therapy, due to the lack of normative data in this area.

A study of phonological development will enrich the research on the phonology of the language under consideration. The two main aims of this thesis are the following: The first aim is to account for phonological acquisition of Kuwaiti-Arabic speaking children, providing the first normative data on this population. The second aim is to investigate phonological acquisition in typically developing Kuwaiti Arabic-speaking children and to compare their patterns with those of children acquiring other dialects of Arabic and other languages (mainly English).

The structure of the thesis is as follows: Chapter 1 reviews the existing literature on theories of phonological development and highlights some known influential factors in the course of phonological acquisition. Chapter 2 explores the existing developmental studies of phonological acquisition from a cross-linguistic perspective, proposes factual differences, and highlights some critical methodological issues leading to the formulation of the research questions in Chapter 4. Chapter 3 provides general information about the Arabic language with a special focus on the Kuwaiti dialect of Arabic. This chapter also offers an overview of Kuwait's demographic history and population. Chapter 4 details the methodological procedures used in the current cross-sectional study. Chapter 5 details the characteristics of the phonological systems of 70 typically developing Kuwaiti-Arabic speaking children and documents developmental change across seven age bands between 1;4 and 3;7. Chapter 6 brings together the findings of the current study and those of earlier studies on the development of child phonology in English and other dialects of Arabic, and attempts to answer the research questions posed in Chapter 4. The final chapter will also revisits factors influencing phonological acquisition which were reviewed in Chapter 1. It concludes by highlighting the theoretical and clinical implications of the data derived from the current study, and outlining future research plans.

Chapter 1:

Introduction

1. Chapter One: Introduction

1.1. Introduction

The development of meaningful speech is a complex process. In terms of phonological development, children must learn the movements needed to produce words to match the adult targets; they must also be aware of the phonological forms of words in their native language. This complex process has two fundamental components: first, a biologically based component associated with the development of the speech–motor skills required for the production of adult-like words; and second, a cognitive-linguistic component associated with learning the phonological system of the ambient language. These two components are interactive and are believed to co-occur simultaneously to shape the child's phonological system.

Long before the field of child language acquisition began to bloom, there was considerable interest in determining the age at which most children are able to accurately produce the sounds of their language. There was a need to establish developmental norms, which in turn resulted in establishing research interest in the field of phonological acquisition. Such a venture has inherent countless methodological and theoretical debates (Vihman, 1993, 2014). The concerns are mainly related to methodological issues, especially with regards to the criteria used to identify ages of acquisition. Cross-linguistic studies contribute to our understanding of language universals by comparing developmental patterns across different languages. To ensure these studies are effectively comparable, the criteria used in the data collection and analysis should be clearly defined and made available to other studies. When this is not the case, the comparisons would result in misleading generalisations.

A vast number of published studies on phonological acquisition exist, which yield varying data and conclusions regarding normative acquisition of various languages. In order to identify typical developmental patterns of children

acquiring their language or language pairs, it is essential to evaluate methodological differences that might influence the reported ages of acquisition.

The main aim of phonological acquisition theories has been to provide universally valid explanatory concepts for speech acquisition. All theories emphasise the similarity found across languages and also highlight language-specific differences. However, theories do not agree on which aspects of speech development are of a universal nature, whether they are innate or not, and most importantly, how children begin to learn the phonology of their languages, and what units are considered the building blocks of phonological acquisition.

The following section will begin with a brief overview of phonological acquisition theories and basic phonological units; this will be followed by a discussion concerning potential influential factors on the order of phonological acquisition, with a focus on the development of phonological universals and language-specifics.

1.2. Theoretical overview

One of the earliest theories of phonological acquisition stemmed from Jakobson's (1968) structuralist approach; Jakobson (1968) hypothesised that the acquisition of phonology can be described as a universal innate process which is governed by the acquisition of 'simple, clear, stable phonic oppositions, suitable to be engraved in memory and realised at will' (p. 30). Jakobson described phonological learning as the emergence of phonological contrasts according to an implicational hierarchy; that is, 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/ while a language with /t/ is less likely to have /d/). The phoneme whose presence is implied is likely to be unmarked (more on this in section 1.4.1 below). Jakobson's theory also posits that the development of a phonological system is progressive and requires a gradual differentiation of a sequence of oppositions affecting consecutively smaller sound classes based on the principle of maximum contrast that is consistent with the adult phonological systems (i.e.,

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'implicational laws'). Jakobson suggested that whether a sound would be acquired early could be explained in terms of the distribution of the sound among the world's languages. The more widely a sound is distributed, the earlier it will be acquired. According to this view, nasal, front consonants and stops would be acquired earlier than their counterpart oppositions; that is, orals, back consonants and fricatives, respectively. Although this accounts for the frequency of sound occurrence across languages, but it does not take into account the functional load of the sound within language. This view also overlooks the articulatory complexity of a phoneme as it occurs in different word structures across languages (e.g. consonant clusters or complex word structures).

Chomsky and Halle (1968) took a different point of view concerning the question of universality. They proposed the principles of *generative phonology*, which has as one of its basic views that children's speech acquisition results from the application of a set of phonological 'rules' applied to abstract underlying forms similar to those of adults. In contrast to Jacobson's implicational laws, Chomsky (1965) argued that the child is innately provided with a 'tacit knowledge' of universal principles of language structure (hence the term 'rules'). Chomsky and Halle (1968) described phonological 'rules' as one aspect of the general linguistic framework that is based on distinctive features. They argued that phonological rules operate on underlying lexical representations derived from adult surface forms, which are accurately perceived and stored to interact with the child's output. Throughout the course of development, the child gradually unlearns those, resulting in the acquisition of additional features. This led to the introduction of Chomsky and Halle's (1968) *Sound Pattern of English* (SPE) feature system.

The SPE system categorises sounds based primarily on the movement of the articulators. Chomsky and Halle's system was designed to account for all articulatory properties of human speech and 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 to incorporate both acoustic and articulatory properties of the sound (e.g.,

Bernhardt & Stemberger, 1998; Clements, 1985; McCarthy, 1988; Sagey, 1986).

Based on Chomsky & Halle's generative framework, Stampe (1969) analysed his son's speech from the age of 2;0 to 4;0. He applied the full set of rules applicable to mapping a child's presumed 'underlying forms' to his son's surface phonetic forms (i.e., adult target). He also performed an independent analysis in which a child is seen as having a system of his own that differs from the rule set expressing the adult-to-child mappings. Based on his findings, Stampe (1969) proposed the theory of *natural phonology,* which suggests a set of universal and innate 'phonological processes' (c.f. Chomsky & Halle's 'rules') is applied to both adult and child speech. As the child is exposed to the phonology of a particular language, he or she must learn to suppress those processes that do not occur in the language in order to develop an adult-like phonological system. This framework, however, does not provide sufficient accounts for individual variability that are often observed in the development child speech.

In contrast to the theories described above, which perceive the acquisition as a linear process, non-linear theories share a basic concept, which sees the child as starting the language learning process within the context of a phonological representation framework and a set of universal principles or 'templates' (Bernhardt & Stoel-Gammon, 1994). Researchers who followed the non-linear framework of phonology (e.g. Fikkert, 1994; Levelt, 1994; Stemberger & Stoel-Gammon, 1991) were concerned with the acquisition of segmental and supra-segmental phonology. According to the non-linear phonological framework, exposure to language input confirms the universally determined representation and also allow the less universal (i.e., more marked) aspects of the phonological system to be learned. The template that contains the information is thought to comprise basic syllable structures and the least marked or basic segmental features. 'The universally determined representational framework can be described as a passive "filter", both for perception and production' (Bernhardt & Stoel-Gammon, 1994, p.132).

The non-linear phonology concept lies in the hierarchical nature of relationships among phonological units such as syllables or words in contrast to individual

segments or features; the phonological processes or rules are only seen as a useful tool to describe the differences between the child's developing phonological system and the adult phonological system (Bernhardt & Stemberger, 1998). Changes in the system are thought to be caused by maturation of the perceptual and productive systems, continuous exposure to the information, which forces recognition, or both maturation and exposure acting together to shape the child's developing phonological system.

More recently, Optimality Theory (OT) was introduced (Prince & Smolensky, 2008a, 2008b); this theory extends the concept of non-linear phonology by suggesting a formal framework that contrasts with the rules-and-representations approach of classical generative phonology. The OT approach can be described as a series of stages that result in the conversion of underlying to surface representations (Hayes, 1999). This approach suggests that universal constraint sets are of two basic types: *markedness* constraints, which disallow the presence of marked structures in the output (e.g., a constraint on final consonants), and *faithfulness* constraints, which require a match between the input and output. According to OT, phonological acquisition is viewed as the process of ranking and re-ranking constraints to conform to the constraint patterns of the ambient language (for an overview see Dinnsen & Gierut, 2008). OT constraints are not limited, which reduces it predictive value in defining the process of development in child's speech.

In general, formal models tend to overlook intra- and inter-group variability in children's linguistic performance. Also, most (but not all) formal models have no direct accounts for frequency effects on the course of speech development. Both variability and frequency effects were accounted for in functional models of the phonological theory. In contrast the previously presented approaches to speech acquisition, the following three models offer an entirely different method: the *behaviourist approach,* the *cognitive approach* and the *biological approach.*

The behaviourist theory (e.g. O. Mowrer, 1952, 1960; Olmsted, 1966, 1971) suggested that contingent reinforcement holds an essential role in phonological acquisition. The theory held that the general ability to learn a language is innate

as opposed to being based on any sort of linguistic unit that triggers phonological development. In 1952, Mowrer proposed a learning theory that suggested four steps to vocalization, including attention and identification with the caretaker. In 1966, Olmsted added a specific course of phonological acquisition based on Mowrer's learning theory. It posits that phonemes are acquired in a hierarchical fashion according to two factors: frequency of occurrence in input and ease of perception. According to Olmsted's view, language universal aspects should be dependent on a universal ability of perception, and language-specific phonological variations can be accounted for by frequency of input. This concept has introduced the notion of language-specific patterns within the earlier proposed language universals.

Cognitive models support the behaviourist theory on the presence of innate perceptual abilities. Cognitive models suggest that the child plays an active role in the process of the development of speech, in contrast with the behaviourist model where the child's role is rather passive. Both cognitive and behaviourist models agree that the child is challenged during the course of acquisition, with general, 'natural' perceptual and sound production capacities. However, the cognitive models question the presence of specialized or innate knowledge of language structure (Ferguson & Farwell, 1975). According to the cognitive models, babbling is considered a continuation stage that precedes speech production and function as a practicing phase for motor activities. That is, the child develops speech by formulating and testing hypotheses of the sound system being acquired. Ferguson and Farwell (1975) suggest that the 'universal phonetic tendencies' are derived from the universal physiology of the human vocal tract. This model suggest that exposure to the ambient language would eventually lead to the acquisition of language-specific phonemic system.

The biological models take a similar point of view in terms of continuity between babbling and speech to that of cognitive models. Those models emphasize the role of perceptual and articulatory constraints that govern the children's phonological acquisition (Kent, 1992; Locke, 1980, 1983). In support of the continuity model, Locke (1983) found that the phonetic inventory of the pre-linguistic stage carries significant resemblance to that of the early linguistic

stage. Furthermore, Locke's claims that children exposed to different languages share very similar babbling patterns has led to the assumption that babbling patterns are of a universal nature and that phonological development is part of a general maturational course, which are guided by universal physiological, perceptual and cognitive abilities.

In summary, all theories try to account for universal trends (to a certain extent) in the course of phonological acquisition despite the continuing debate about the underlying units of the child's phonological system. Many cross-linguistic studies that examine various phonological units support the claimed universality over the course of the acquisition of child phonology. Thus, the main aim of cross-linguistic studies is to determine prominent influential factors that guide the development of the child's phonological system. For instance, the influence of ambient language on the development of language-specific patterns is rather indirect; few factors could resolve the on-going debate on how to establish which units are determined by language universal set and which are language-specific patterns. To answer this question, we need to identify phonological universals and language-specific patterns in the order of acquisition of speech sounds, by comparing phonological development of different languages in terms of rate and order of consonantal acquisition, error patterns and syllable structure.

Different theories hold different views on the basic units of phonological representation. The basic units of acquisition vary and can include the following: a distinctive feature (e.g., Jakobson's structuralist model), 'bundles' of features that constitute segments (e.g., Stampe, & Smith's generative models), suprasegmental units (nonlinear phonology, e.g., Bernhardt & Stoel-Gammon, 1994) or templates and whole-words (Ferguson & Farwell, 1975; Ingram, 1989; Macken, 1993; Menn, 1983; O. Mowrer, 1952, 1960; Olmsted, 1966, 1971; Vihman, 1996). Despite this disagreement, the majority of researchers acknowledge that theories of linguistics should be learnable, and as such, empirically verified against language development facts. The question, then, is not about which units of phonological acquisition should be considered, but more importantly about the *way* they influence acquisition order and how they

are incorporated into theoretical debates.

The following section will present a brief overview of the basic phonological units in the child's speech before embarking on a discussion of influential factors that result in the acquisition of phonological universals and language-specific patterns over the course of phonological development. The focus of this review will be mainly on speech sound and syllable shapes that occur in the child's production of meaningful utterances.

1.3.   Phonological units in children's acquisition

The main goal of early studies of child language acquisition is to explain the language acquisition process and to investigate how learning is accomplished in the presence of incomplete and often contradictory input. Many studies are motivated by Chomsky's (1965) views on how much grammar is innate and how much is learned. Children follow different pathways in developing their phonological system; while it always leads to the same, rather complex, adult system, there is a great deal of variability in their developmental paths. The study of child phonological acquisition requires an in-depth exploration of the basic phonological units that constitute the child's phonological system. Therefore, it is essential to consider the ultimate source of the *phonological system*, and how it is hierarchically structured to make up the native speaker's knowledge of their language-specific phonological system. Similar to the categories of the *linguistic system, semantics* and *syntax,* the *phonological system* consists of *phonetics* and *phonology*.

The difference between phonetics and phonology is that phonetics deals with the physical production of these sounds (articulatory and motor skills) while phonology is the study of sound patterns and their meanings both within and across languages (functions, behaviour and organization of the speech sound system) (Vihman, 1996).

The following section presents an overview of the phonological system from a non-linear perspective (Bernhardt & Stemberger, 1998) to illustrate phonological units at several levels. The system 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 1.1 illustrates the phonological hierarchy of this framework, where features (the smallest units) combine together to build segments (consonants, vowels), syllables, feet and prosodic words. The following paragraphs will describe each level (or tier).

The phonological features tier consists of the smallest units that speech sounds are composed of; they encode the phonetic information of segments of speech (either acoustic or articulatory). Jakobson (1968) posited a theory of distinctive features, in which the phoneme consists of a bundle of binary (i.e., they have either the value + or -) and privative features (i.e. either present or absent). The presence of other features may in turn depend on the presence of these privative features. The phonological feature is described according to its acoustic properties, which are based on the physical characteristics of the sound wave produced by speech (Ladefoged, 2005, p. 8).
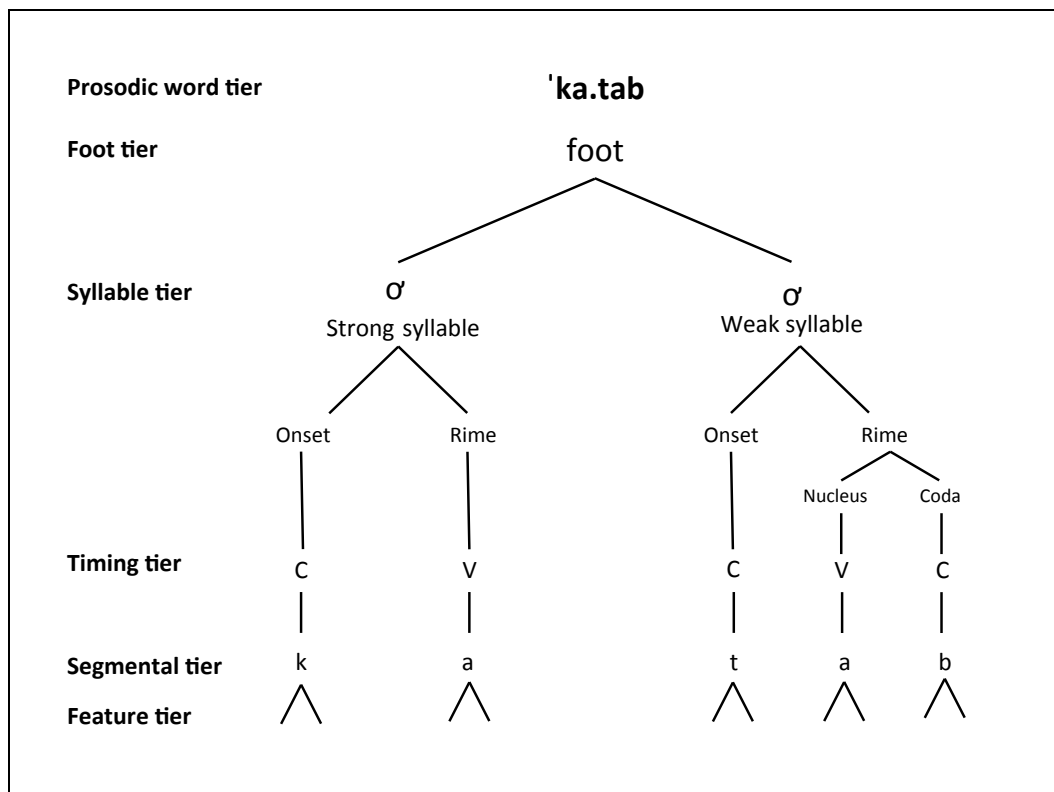
Figure 1.1: Hierarchy of the phonological elements

The most prominent features are those distinguishing between vowels and

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consonants ([sonorant], [vocalic] and [consonantal]); those distinguishing the sounds in terms of place of articulation ([anterior], [coronal], [high], [low], [back] and [rounded]); and those distinguishing the sounds in terms of the manner of articulation ([nasal], [lateral], [continuant], [delayed release] and [stridency]). The features are labelled as marked (less frequent, more complex) or unmarked (more frequent, less complex). Each phoneme is described by a combination of features. For example, an unmarked feature would be [coronal, +anterior], e.g., /t/, /d/, /n/, and a marked feature would be [dorsal], e.g., /k/, /g/, /ŋ/.

The segmental level represents the segment, which is defined as 'any discrete unit that can be identified, either physically or auditorily, in the stream of speech' (Crystal, 2003, pp. 426). The term 'discrete' is used to define the segment, which are separate and individual, such as consonants and vowels, and occur in a distinct temporal order. Phonological segments represent the phoneme, which is the smallest segmental unit of sound employed to form meaningful contrasts between utterances. The phoneme is often described using traditional labels in the taxonomy of oppositions such as voice, place and manner of articulation. The suprasegmental units, such as tone, stress and secondary articulations such as nasalization, may coexist with multiple segments and cannot be discretely ordered with them.

Above the segment tier, are the three basic levels of prosodic structure: timing units, syllables, feet and prosodic words (figure 1.1). The timing units differentiate elements by their rhythmic status in the syllable and word. These units are considered as independent phonological elements. Timing units include a mora (μ), which is considered as a syllabic building block that determines syllable weight. The mora is often employed for the analysis of stress and timing in some languages, such as in Hawaiian and most dialects of Japanese, in which stress is contrastive.
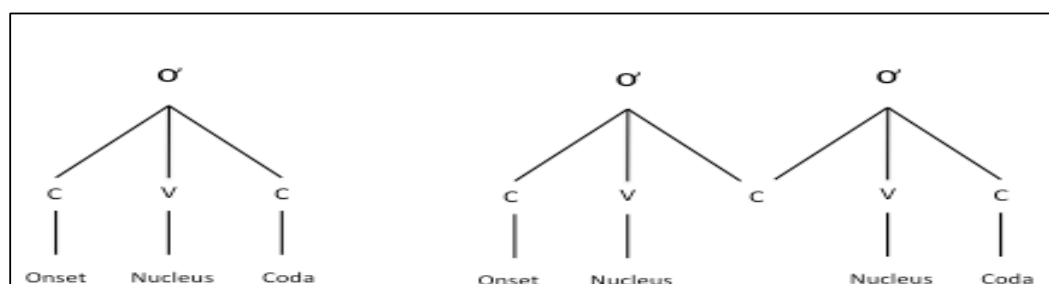
Figure 1.2: The syllable structure

The next level above the timing unit is the syllable, which functions as a grouping of the segments and their features, and the timing units. A syllable consists of a nucleus (Nu), which is usually a vowel. The Nu is often preceded by an onset (On) and followed by a coda (Co). The Nu of the syllable plus the Co consonants that follow are often referred to as the rime. For a single-syllable word, all segments before the Nu are in the On (figure 1.2). There is conflicting evidence regarding intervocalic consonants; they could either be the coda of the first syllable, the onset of the second one or ambisyllabic (figure 1.2).

The next highest level of the hierarchy is the foot (figure 1.3). The foot is a major unit of measurement relating to stress assignment (as are timing units).
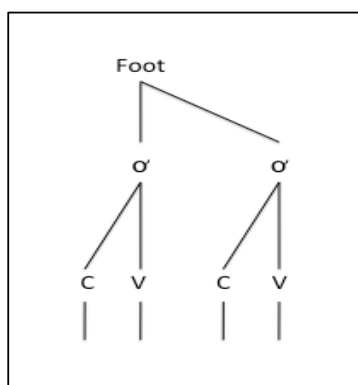
Figure 1.3: The foot structure

The foot contains a stressed syllable, which is its nucleus. If the first syllable is stressed then the foot is left-prominent, or trochaic; for example, in the English word *poppy* /ˈpɑː.pi/. Equally, if the second syllable is stressed the foot is right-prominent, or iambic; for example, the English word *salon* [səˈlɑːn]. In the field of phonology, the 'foot' concept is often used to measure the word length and stress patterns.

Both observational and diary studies agree that children pass through a period of regression in accuracy after the onset of their first words accompanied by an increase in systematicity or inner coherence among their own forms. Ingram (1974) argues that the process of reorganization occurs in a systematic order within specific time frames and without explicit instruction. In other words,

reorganization is attributed to development of word templates that have a consistent phonological pattern, derived from *implicit* perceptual and motor learning. The templates are abstract phonetic production patterns that integrate the adult target with the child's most common vocal patterns and result in *explicit* word learning. The argument to be made here is that the child constructs his or her phonological system via two supportive routes: *explicit* and *implicit* learning. *Explicit* learning refers here to learning with attention, while *implicit* learning happens unintentionally through mere exposure to a set of patterns. In child phonology*, explicit* learning begins with the lexicon (Vihman, 1996) rather than with the minimal units of phonetics or phonology (Ingram, 1992; Jakobson, 1941, 1968). For instance, the child intentionally aims to replicate the adult's verbal behaviour by matching their sound patterns with vocal production in an attempt to produce a word or a phrase (Velleman & Vihman, 2002). *Implicit* learning refers to 'the development of expectations about the frequencies of occurrence, or probabilities, of various linguistic events (such as the production of particular syllable types) in the language(s) the child hears—or overhears' (Velleman & Vihman, 2002, p. 10). In other words, the child 'accidently' learns patterns that occur frequently in a language even with the absence of attention.

One of the major debates in the study of child phonology revolves around the degree of representational abstraction required to model children's grammar. The discrepancy between child forms and adult forms results from a lack of agreement on the phonetic or phonological level at the beginning of the acquisition process and throughout the developmental period. Because most of the developmental studies concentrate on segment production (or other phonological units), it seems to be impossible to pinpoint a specific time at which a shift to segmental representation is completed due to the extensive production variability in child speech during the course of development.

The following sections will highlight several aspects that are believed to influence the child's acquisition of phonology.

1.4.   Influential factors in the course of phonological acquisition

Children's speech sound development can be analysed by looking at *phonetic* as well as *phonological* acquisition. A distinction can be made between *phonological* development in words and *phonetic* development prior to word learning (Winitz, 1969). The latter is believed to have a physiological basis and involves learning sounds of the ambient language. The former implicates a stable sound-meaning relationship and involves a physiological process to a lesser extent. The review will focus predominantly on *phonological* development. Children's phonological acquisition is a complex process, which is determined by, among other factors, physiological and motoric aspects of speech articulation, perception-related issues, lexical and grammar development and the influence of ambient language. This section will focus on the influential aspects of the ambient language that are thought to determine the order in which children acquire sounds: markedness hierarchy, phonological saliency, input frequency, and functional load.

1.4.1. Markedness

The notion of markedness has often been reported in studies of language acquisition to explain the relative relationship between several linguistic elements (e.g. syntax, semantics, and phonology) (Hume, 2006). In the field of phonological acquisition, the markedness concept has acquired broader meaning; it has become a cover-term for properties such as natural/unnatural, frequent/infrequent, common/uncommon, easy to produce/hard to produce, acquired earlier/acquired later and so on. Central to markedness is the notion of opposition (Trubetzkoy, 1969); that is, one member of an opposition is considered marked, while the other is unmarked. For instance, for the nasality feature [nasal], the feature value [+nasal] may be considered marked, and the value [-nasal] unmarked (Rice, 1999).

Markedness values are determined by a variety of factors, such as: asymmetrical patterning in phonological processes, asymmetrical distribution in phonological systems, cross-linguistic frequency of sound types, child language acquisition, phonetic factors (perceptual salience, articulatory complexity), implicational relations and sound change. Compared to its marked counterpart,

an unmarked sound is generally assumed to be:

a. more frequent across languages
b. the target of processes such as reduction, deletion, assimilation and metathesis
c. the output of processes such as epenthesis, neutralization and the result of sound change
d. more phonetically variable
e. more widely distributed
f. acquired earlier
g. preserved in the formation of creoles (e.g., loanwords) (Hume, 2006).

Articulatory complexity been drawn on to predict markedness of a segment (e.g. Calabrese, 1995). The unmarked member of an opposition is considered to be easier and less complex than the marked counterpart in terms of production. For example, the less marked nature of certain feature combinations can be explained by ease of articulation and perceptual saliency, therefore, sounds that are easier to articulate are generally assumed to be:

a. more frequent cross-linguistically (e.g., [t] vs. [ʧ])
b. less stable phonetically (e.g., more variable)
c. more likely to undergo reduction, deletion and assimilation
d. the result of neutralization (e.g., Korean: aspirated, tense and plain stop are neutralized in coda position)
e. acquired earlier, and so on.

These claims are generally considered as some of the diagnostics of markedness. However, patterns contradicting the markedness parameters are commonly observed. The following section will discuss issues of controversy around the influence of perceptual salience and frequency of occurrence on order of acquisition.

The perceptual salience of sounds has also been drawn on to predict observed asymmetries in phonological systems (e.g. Blevins, 2004; Hume, 2011; Hume & Johnson, 2001; Lindblom, 1990; Trubetzkoy, 1969; Waugh, 1987). Perceptual

salience plays an important role in the identification of speech sounds (e.g., Kawasaki & Ohala, 2005; Lindblom, 1990; Ohala & Kawasaki, 1997). Kawasaki (1982) proposes that the greater the magnitude of the modulation, the better a given signal is detected (i.e., sharper changes in the speech signal increase the salience of cues in the signal). Interestingly, this proposal relates to claims regarding phonological markedness in two seemingly conflicting ways. On the one hand, patterns with *high salience* tend to recur across languages, since they are more resistant to change than those with low salience. In this case, greater syntagmatic distinctiveness correlates with unmarkedness. The common assumption is that the CV syllable (unmarked) is universally preferred over other syllable types, e.g., V, CVC, VC (Cairns & Feinstein, 1982; Clements & Keyser, 1983). Generally, high salience has also been proposed as the explanation for reoccurring phonological inventories (Flemming, 1997). On the other hand, the structures with *low salience* due to weak acoustic/auditory cues are generally assumed to be less stable phonetically (Kawasaki 1982) and thus subject to phonological processes such as assimilation, reduction and deletion to a greater degree than sounds with robust cues (e.g. Boersma, 2002; Hayes, Kirchner, & Steriade, 2004; Kohler, 1990; Steriade, 2001). Thus, low saliency is also correlated with being unmarked.

The use of perceptual salience appears contradictory as a markedness diagnostic: unmarkedness is associated with high salience (i.e., *strong* perceptual distinctiveness) as well as low salience (i.e., *weak* perceptual distinctiveness). Therefore, it is apparently impossible to predict a priori whether a sound is marked or unmarked given its salience (for further details, see Hume, 2006).

The influence of frequency of occurrence on markedness has received relatively less attention in the literature (though see, e.g. Battistella, 1990; Greenberg, 1966, 2005; Trubetzkoy, 1969). There has been considerable evidence of variability in the order of acquisition across languages against the presumed influence of frequency on acquisition. Early sensitivity to the frequency of phonological segments was found cross-linguistically. For instance, Hume and Tserdanelis (2002) pointed to the higher frequency of labial

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place in Sri Lankan Portuguese Creole nasals as support for the unmarkedness of the labial nasal in that language. Rice (1999), on the other hand considered a pattern's frequency to be a consequence of emergent properties (i.e., factors influencing language change), rather than a diagnostic for markedness (also see Lacy, 2002, 2006).

Regarding the effects of frequency on the acquisition of phonological segments, a comparison of the accuracy of production of the voiceless affricate /ts/ in Greek (Mennen & Okalidou, 2007) and Cantonese (So & Dodd, 1995), showed that Cantonese-speaking children were able produce /ts/ at a much higher accuracy than Greek-speaking children at the age of 2;0 and 3;0. This difference in the rate of acquisition has been attributed to the difference in phoneme frequency of /ts/ in the two languages, as the /ts/ is considerably less frequent in Greek than in Cantonese (Edwards & Beckman, 2008). Similarly, on the prosodic level, Spanish-learning children tend to acquire initial weak syllables several months before English-learning children. In contrast, English-learning children acquire coda consonants several months before Spanish-learning children (Demuth, 2001) (see section 1.5.3 for details).

Several cross-linguistic studies of child phonological acquisition found that frequency can influence the order of emergence and the accuracy of production of segments. For example, Stokes and Surendran (2005) compared speech samples of children acquiring English and Cantonese. The results showed positive correlation between the age of emergence and the frequency of word-initial consonants ($r = -.79$, $p < .01$ for Cantonese; $r = -.52$, $p < .01$ for English): consonants that are produced frequently in the input language are acquired earlier than consonants that are produced rarely. Similarly, Zamuner, Gerken, and Hammond (2005) showed significant correlation between the frequency distribution of codas in the speech of English-speaking children (N = 59, age range: 0;11 – 2;1) and the relative frequency of those codas in child-directed speech. The results showed that consonants frequently used by adults are also likely to be produced by children in the early lexical period. Thus, children appear to be sensitive to the frequency of patterns in the ambient language when building and organizing their phonological system.

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Likewise, Kirk and Demuth (2005) found that English-speaking children tend to acquire coda clusters before they acquire onset clusters. This finding reflects the frequency of coda clusters in adult speech. Kirk and Demuth (2005) also found that the first coda clusters to be acquired are the highest frequency stop + /s/ or /z/ clusters, as in *box* [bɑks]. Furthermore, metathesis errors turned the lower frequency /s/ or /z/ + stop clusters (e.g., *wasp* [wɑsp]) into the higher frequency stop + /s/ or /z/ clusters (e.g., [wɑps]). Thus, some of the error patterns show an early preference for high frequency phonological structures in children's productions.

Furthermore, the influence of place of articulation on the development of segmental error patterns was also documented. For example, Morrisette, Farris, and Gierut (2006) examined the inventory structure and substitution patterns of 211 English-learning children to test Jakobson's (1968) claim that dorsal place of articulation is marked compared to coronal place of articulation. However, they found that there is a great deal of variability in children's sound production across all age groups, and there were no consistent patterns or order of acquisition to prove the claim in question (See also Beckman & Edwards, 2003; Menn, 1983; Vihman, 1993). Also, Beckman, Yoneyama, and Edwards (2003) study of the acquisition of place of articulation also challenged the view of the universal order of acquisition for place of articulation. They found that Japanese-learning children made more than twice as many *backing* errors for /t/ (i.e., /t/→[k]) as they made *fronting* errors for /k/ (i.e., /k/→[t]). Their findings did not the support their prediction of back consonants like /k/ are universally marked and likely to be replaced by front consonants like /t/.

In general, the markedness concept is widely criticized as it makes predictions about universal patterns; however, it is silent about what is predicted at the level of the language specifics (Hume, 2011). Although markedness seems to be language specific, Dinnsen, Chin, Elbert, and Powell (1990) offered a model with an account for cross-linguistic comparisons of the sequential nature of phoneme acquisition. The model accounts for the child's underlying (input) representations (c.f. OT) based on the parameters of markedness to dictate the

order in which features are acquired; the presence of marked features implies the presence of unmarked ones in a child's phonetic inventory ('*chain shift*') (Dinnsen et al., 1990). Dinnsen et al. (1990) suggested that children's phonetic inventories were categorized into five levels of complexity (A through E). Level A referred to a phonetic inventory that included mostly unmarked sounds (e.g., nasals, stops and glides), whereas Level E referred to a phonetic inventory that included more marked, later-developing sounds (e.g., fricatives, affricates and liquids). Dinnsen el al.'s findings agree with the notion of markedness where classes of speech sounds are acquired in a simple-to-complex fashion during phonological acquisition.

Dinnsen, Chin, and Elbert (1992) proposed a universal hierarchical structure with a highly limited set of ordered features that might be applicable to phonetic inventories of all languages. Based on this model, each feature in the hierarchy had a number of default specifications (i.e., unmarked values). Therefore, children speaking a particular language would acquire its sounds by a process of replacing a default value (ummarked) with a language-specific value (marked) (Edwards and Shriberg,1983). The order of phoneme acquisition would therefore follow a hierarchical relationship and default values: default features would be acquired before non-default features; features ranked highly in the hierarchy would be acquired early.

Dinnsen et al. (1990) examined this model by investigating the phonological acquisition of 40 monolingual English-speaking children with phonological disorders, aged between 3;3 to 6;6. The results of their study showed that, in general, English-speaking children acquire unmarked sound classes before marked sound classes, indicating that implicational laws govern the order of acquisition, that is, the presence of one phoneme in a language implies the presence of another phoneme. Although Dinnsen et al.'s model offers a different account for cross-linguistic comparisons of the order of phoneme acquisition; the explanatory power of this model has so far rarely been applied to the phonological acquisition of children other than English- and Spanish-speaking children. This model was not applied to normative developmental data as it was initially validated with data from children with phonological disorders. It

is possible that the application of this model on normative data with larger inventories is a rather complex process.

In general, the influence of markedness on the order of phonological acquisition has been an issue of debate; namely, the extent to which there is a universal order of acquisition such that the marked implies the unmarked remains questionable. Consequently, looking at specific parameters of linguistic markedness is more likely to represent some universal tendencies in phonological development, as there are many exceptions too.

1.4.2. Phonological saliency

In the field of phonological acquisition, many researchers have used the sonority hierarchy as a diagnostic measure of linguistic markedness (Battistella, 1990; Hume, 2006; Rice, 1999). Phonological saliency has been used to determine the order of acquisition in a few languages (Putonghua: Hua, 2000; Cantonese: So & Dodd, 1995; Quiché: Pye et al., 1987) and to determine the rate of acquisition across languages (D. Mowrer & Burger, 1991). However, the definition of 'phonological saliency' varies among different researchers.

Studdert-Kennedy (1986) proposed that sounds with higher perceptual saliency are highly noticeable, and therefore most likely to be attempted by the child. For some researchers like Vihman (1993), how salient sounds are may actually be related to the child's own vocal practice. Vihman (1993) proposed the idea of an *articulatory filter,* which she defined as 'a phonetic template (unique to each child) which renders similar patterns in adult speech unusually salient or memorable' (p. 155). Her suggestion is that the child chooses words to imitate based on their knowledge of their own vocal motor schemes, so that patterns in the input that match those schemes are the ones most likely to capture their attention.

There has been a growing interest in exploring the role of perceptual phenomena in accounting for crosslinguistic sound patterns (e.g. Côté, 1997; Flemming, 1997; Hayes, 1999; Hume, 2006; Ovcharova, 1999; Silverman, 1995; Steriade, 1997). The effects of perception followed the development of OT (McCarthy & Prince, 1990; Prince & Smolensky, 2008a) in which perceptual

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constraints were described as part of the linguistic markedness hierarchy rather than an independent parameter.

Phonological saliency, in the context of the current study, is different from linguistic markedness. The concept of phonological saliency is cognitive in nature and characterizes the noticeability of certain linguistic forms to children (Yavaş, 1998). Phonological saliency is similar to markedness in the sense that both are orderly ranked in a progressive manner. Both markedness hierarchy and phonological saliency account for perceptual salience (Prince & Smolensky, 2008a), frequency and articulatory ease (Stokes & Surendran, 2005). In contrast to the markedness parameters of phonological saliency, which are mainly perceptual in nature, the sonority index of phonological saliency (figure 1.4 below) accounts for both perceptual and articulatory parameters (Yavaş, 1998).

The sonority index is based on two main factors: the degree of opening of the oral cavity in producing the sound and the sound's propensity for voicing (Yavaş, 1998). The degree of oral cavity opening represents the sound's sonority level, where the more open the articulation of the sounds, the greater its sonority level. When the degree of opening is matched, the voiced sound will have greater sonority than its voiceless counterpart (Yavaş, 1998). It suggests that the more sonorous a sound, the easier it is to be perceived and therefore, acquired. For the acquisition of consonantal clusters, the greater the sonority difference between the first and the second member of the cluster, the more natural it would be (therefore, easier to acquire).

1	2	3	4	5
stops	*fricatives*	*nasals*	*liquids*	*glides*

least sonorous   most sonorous
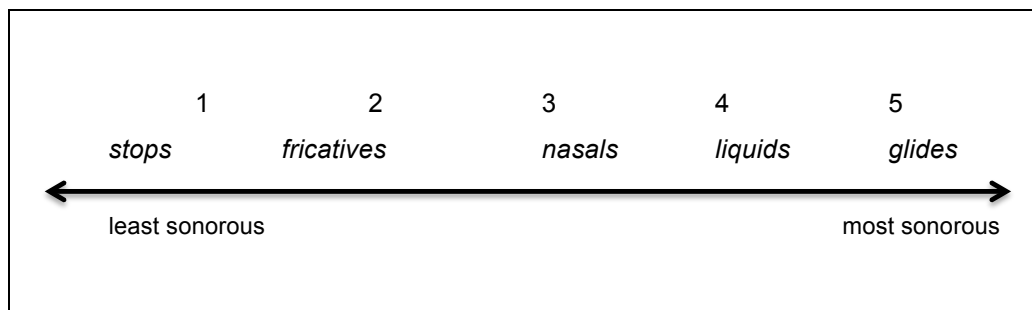
Figure 1.4: The sonority index (Yavaş, 1998, p. 184)

The concept of phonological saliency could be a valid measure to predict order of acquisition in child phonology. According to phonological saliency, vowels, glides and nasals are presumably acquired before stops, fricatives and affricates. Vowels, glides and nasals are more sonorous and therefore acquired early. Sonority sequence constraints are also postulated, which appeal to the sonority distance between two sounds (S. Davis, 1990). The Sonority sequence constraint posits that the greater the sonority distance between two segments in a cluster, the least marked the cluster is. For example, in a language that has clusters with smaller sonority distance, it is expected that the same language will also have cluster with a greater sonority distance. It is therefore expected that clusters with greater sonority distance would be acquired before those with smaller sonority distance; for example, in Kuwaiti-Arabic /dla:q/ 'socks' is expected to be acquired before /dmu:ʕ/ 'tears'.

Pye et al. (1987), investigated the early acquisition of [ʧ] by Quiché-speaking children. Pye et al. explained the acquisition order from the concept of maximal opposition within the language which children begin to use phonological contrasts; given that [ʧ]-[t] opposition in Quiché is more salient than in English, it was acquired earlier by Quiché-speaking children compared to English-speaking children. Furthermore, Hua (2000), in her cross-sectional study of 129 Putonghua-speaking children aged 1;6-4;6, found that the saliency values of the four syllable components in Putonghua are congruent with their acquisition order: tones were acquired earlier than syllable-final consonants and vowels, which were acquired earlier than syllable-initial consonants; moreover, the features of 'weak stress' and rhotacization were acquired last due to their low saliency value. Phonological saliency, as defined by Hua (2000), is a language-specific concept; that is the saliency level of a particular phonological feature is determined by its role within the phonological system of the language, and may not apply to other languages.

Differences in the saliency of individual components in different languages may result in the cross-linguistic variations in the rate of acquisition. Hua and Dodd (2000) argued that the number of options within a syllable component may

determine the rate of acquisition when other factors are equal. Hua & Dodd (2000) found that Putonghua-speaking children's tonal acquisition was more rapid than that of Cantonese-speaking children. Tone is a compulsory syllable component that differentiates lexical meaning in both languages. However, the difference between Cantonese and Putonghua is that the former has nine tones while the latter has only four. The data was compared to the four children in So & Dodd's (1995) study. Cantonese-speaking children were found to master only three out of the nine tones by 1;6, and their acquisition was not complete until 2;0. Data from Putonghua-speaking children showed that only two of the 129 children aged 1;6 to 4;6 made few tone errors. Tone is the most salient phonological component that is specific to most tonal languages; hence, more likely to attract the child's attention. Vihman (1996) suggested that attention plays an important role in shaping the child's sensory capacities in the direction of the phonological repertoire of a specific ambient language (p. 83). According to the notion phonological saliency: if the sound is more salient, it is more likely to attain the child's attention, which could possibly result in early acquisition of some phonological patterns, such as salient geminates in Finnish and Arabic.

Studies of the geminate acquisition have raised the question regarding the saliency of the word-medial position and how it explains the early acquisition of word-medial phonological patterns in some languages. Several studies have shown that word-medial clusters in Finnish are acquired early in development, as compared to word- initial clusters (Kunnari, Nakai, & Vihman, 2001; Savinainen-Makkonen, 2007; Vihman & Velleman, 2000). This has been attributed to various constraint-related factors, from syllable structure constraints (Łukaszewicz, 2007) to morpho-phonotactics and markedness effects (Zydorowicz, 2010). A similar effect has been reported for languages which make use of word-medial geminates, such as in Polish (Szreder , 2007) and long consonants, such as in Welsh (Vihman & Croft, 2007). These studies suggest that the relative ease with which the segments are acquired can be attributed to the salience of the word-medial, intervocalic position. This explanation is further supported by the fact that, in both Finnish and Welsh, word-medial geminates and long consonants often affect word-onset in children's production, causing them either to lose accuracy or to be dropped

altogether. If this is true in the case of the Finnish language, this might explain, to some extent, why word-medial clusters are acquired before word-initial clusters in Arabic.

The influence of sonority on the rate of acquisition has been examined by D. Mowrer and Burger (1991) who found that Xhosa-speaking children acquired most consonant phonemes earlier than their English-speaking counterparts. These discrepancies in consonant acquisition rates between Cantonese, English and Xhosa are compatible with the concept of saliency. Xhosa has 41 consonants and a very simple syllable structure. A typical Xhosa syllable is structured as CV with very few consonant clusters, while English has 41 consonants, a more complex syllable structure and 49 clusters. Although consonants are optional syllable components in Xhosa, the larger number of consonants and clusters in English lowers the saliency of each consonant.

Studies of the acquisition of Arabic phonology, in general, appear to oppose the notion of the phonological saliency in the prediction of the order of consonant acquisition. Ammar and Morsi's (2006) study discussed the application of sonority hierarchy in the development of Egyptian Arabic. The author's found that Egyptian children acquired voiceless stops before their voiced counterparts. Similarly, Amayreh and Dyson (2000) have observed similar patterns of development among Jordanian-Arabic speaking children. According to the sonority hierarchy, voiced stops are expected to appear before the voiceless ones. Moreover, in the context of Kuwaiti Arabic, Ayyad (2011) also found that voiced fricatives and the voiced affricate were less well established in the phonetic inventories of Kuwaiti-Arabic speaking children between 3;6 and 5;2. Apparently, there is a general agreement that Arabic children may learn voiceless stops earlier than voiced ones. This may be due to the fact that voiced stops in Arabic are often pre-voiced and hard to produce. Thus, it is important to examine the association between the salience of a segment and its phonological contrast. For example, the difference between voiced and voiceless consonant contrast needs to account for the phonetic realisation of the same consonant in different languages. Careful examination of data from Arabic-speaking children may reveal that there are other influential factors that

govern order of acquisition, such as syllable structures or the occurrence of salient geminates.

Based on the findings of the Arabic data, it is possible that the degree of phonological saliency is considered to be language specific, as the realisation of a sound in different languages varies considerably. However, the notion of phonological saliency may help in the prediction of the rate of consonant acquisition cross-linguistically if the physical characteristics of each speech sound are considered; such as Yavaş's (1998) approach, which is based on the sonority index.

1.4.3. Input frequency

Studies on infant perceptual capacities (Jusczyk, 1999, 2000; Mehler et al., 1988; Nazzi, Bertoncini, & Mehler, 1998) provide valid evidence regarding the role of variable phonological input in guiding attention to distinctions in the input, namely in differentially *weighing* different phonetic dimensions, depending on frequency of occurrence in the input. Input frequency, as discussed in this section, is different from the relative frequency that is discussed under the markedness section. In this section, input frequency is specifically discussed in the context of the frequency of occurrence of a phonological structure in child directed speech and/or in the child's speech rather than the general relative frequency of occurrence in adult speech of a given language.

The term 'frequency' used in the literature can refer to one of two kinds of frequency. As noted by Van Severen et al. (2012), frequency can be defined in terms of types or tokens. Type frequency refers to the incidence of the segment in unique words in the lexicon, whereas token frequency refers to the raw number of exposures to the segment in a given word position. For example, the frequency of a word-initial segment can be defined as the raw number of tokens of that segment (i.e., token frequency), or as the number of word types in which it occurs as the initial segment (i.e., type frequency). Existing literature cannot answer whether phonological knowledge depends on type frequency or token frequency. There is variable evidence of the influence of input frequency on the order of acquisition. For instance, input frequency is believed to influence the

acquisition of speech sounds (Rose, 2011; Van Severen et al., 2012), and the relative frequency of a particular segment in the ambient language determines its acquisition order (Pye et al., 1987; Stokes & Wong, 2002; Tsurutani, 2007).

The work performed to date on segmental phonology presents a highly inconsistent picture in describing the characteristics of child directed speech and their potential functions (Foulkes, Docherty, & Watt, 2005). Several studies of child directed speech explore the prosodic influence on lexical and grammatical development rather than the segmental phonological and phonetic properties (see also Cruttenden, 1997; Ferguson & Farwell, 1975; French & Local, 1983; Grimshaw, 1990). Tsurutani (2007) investigated the frequency of occurrence of palato-alveolars in Japanese-speaking mothers' speech and the influence of the input frequency on their children's phonological acquisition. Speech samples were collected from six mothers whose children's age ranged from 1;0 to 1;11. The occurrence of palato-alveolars in the mothers' speech was also examined in terms of frequency and phonetic environment. The analysis showed that the frequency of occurrence of /ʃ/ and /ʧ/ in the mothers' speech was higher than [s] in the child-directed speech in the order of /ʧ/, /ʃ/, /s/. The input frequency was reflected in the order of acquisition. The /ʧ/ and /ʃ/ were acquired before /s/ by Japanese children. However, contradicting findings were also reported by C. Levelt and van Oostendorp (2007) who studied the distribution of word-initial consonants in a Dutch sample of child directed speech selected from the van de Weijer corpus (van De Weijer, 1999). They concluded that it did not resemble the order of emergence of these segments in six Dutch-speaking toddlers selected from the PhonBank CLPF corpus (C. Levelt & Fikkert, 2011). These divergent findings may be (partly) explained by differences between the languages investigated concerning the phonetic attributes and the articulatory complexity of the target inventory, the phonotactics of the target language, functional load of other phonological structures and possibly other additional factors.

1.4.4. Functional load

Functional load refers to the relative importance of each phoneme within a specific phonological system (Hua & Dodd, 2006). However, there is still a matter of controversy around how it is calculated. For instance, Pye et al. (1987) studied the development of initial consonants by five Quiché-speaking children and compared the growth in segmental inventories with that of English-speaking children. Pye et al. determined the functional load of a phoneme by its frequency of occurrence in oppositions or minimal pairs. For instance, in calculating the functional load of word-initial /d/, minimal pairs such as *dough-though, dark-park,* etc. play a decisive role. They found that functional load significantly correlates with the order of acquisition of (word-initial) consonants in Quiché-speaking children (*n.*= 5, age range: 1;7 - 3;0) and English-speaking children (*n.*= 15, age range: 1;5 - 2;2). For example, /l/ and /ʧ/ were acquired earlier by Quiché-speaking children because these sounds carry a greater functional load in the Quiché phonological system than in English. However, Pye et al admitted that high frequency of occurrence does not always carry a high functional load. For example, /ð/ is the second most frequent fricative in English (e.g., the, this, that, etc.) but its functional load is relatively small since 'we could change all English /ð/ into [d]s and still communicate' (Ingram, 1989, p. 218).

In support of the role of functional load on phonological acquisition, Stokes and Surendran (2005) reported significant positive correlations between functional load and the order of acquisition in English-speaking children (N = 7, age range: 0;8 - 2;1), suggesting that segments that carry less functional load tend to be acquired late. Also, Amayreh and Dyson (2000), Cataño, Barlow, and Moyna (2009), and So and Dodd (1995) provided further supporting evidence of the positive influence of functional load on the order of consonant acquisition.

However, all these studies lack specific statistical analyses of articulatory complexity and relative frequency to provide a rather convincing case. It has been argued that articulatory complexity and frequency parameters *per se* may not be enough to predict the order of acquisition (Pye et al., 1987; Stokes &

Surendran, 2005), however, it may be possible that both parameters must be taken into consideration to provide valid prediction of order. For example, Amayreh's (2003) study of 60 Arabic-speaking children between the ages of 6;6 and 8;4 years, explored the relative influence of both functional load and articulatory complexity on the acquisition of consonants. Amayreh (2003) concluded that 'late acquisition may be a combination of two factors, a low functional load related to late and inconsistent exposure and the relative difficulty of articulation of some of the consonants' (p. 528).

Hua and Dodd (2000) criticized Pye et al.'s method of determining functional load; first, the sounds that are frequently used by children may not reflect all sounds that are used by adults speaking the same language; second, both English and Quiché languages share the rank-order of frequencies for some syllable-initial consonants; however, the order of children's acquisition did not support the similarities and differences of such frequencies. Hua and Dodd (2000) suggested phonological saliency as a syllable-based, language-specific concept that is determined and affected by a combination of several factors: the status of a component in the syllable structure (i.e., compulsory or optional); the capacity of a component in differentiating lexical information of a syllable; and the number of permissible choices within a component in the syllable structure.

These contradicting findings on the influence of functional load on the order of acquisition may be (partially) explained by differences between the languages investigated concerning the phonetic characteristics and the articulatory complexity of the target inventory, the phonotactics of the target language, and methodological differences between studies of functional load effects. For example, functional load is divided over segments and tones in a tonal language, whereas in a non-tonal language functional load can only be attested for segments (Hua, 2000). Thus, the fact that possible additional factors may have a considerable influence on the prediction of order cannot be ruled out.

1.5.   The development of syllable structure

The acquisition of syllable structure has been insufficiently studied. This is due

to the extensive individual variability that dominates the 'first words' stage (Stoel-Gammon & Dunn, 1985). Children's very first words usually target adult words of simple prosodic structure and segmental make-up – that is, one- or two-syllable word forms with open syllables, no clusters, core consonants (stops, nasals, glottals and glides) and little (if any) consonant or vowel variegation across the word. Despite the documented similarities across children in terms of the sound segment and syllabic types produced, there is often a wide range of differences in the target words that are attempted by children. This discrepancy relates to patterns of preference for, and avoidance of, particular sounds or sound classes or certain syllabic shapes (Ferguson & Farwell, 1975; Vihman, 1996, 2013).

1.5.1 Theoretical background

Theories of phonological acquisition hold different views on the development of syllable structures in children's speech. Jakobson (1968) postulated a universal order of syllable acquisition. He suggested that the first syllable structure to develop was a consonant vowel (CV) or CV reduplicated, followed by CVC and CVCV (with different CV combinations). Jakobson's postulation was based on contractiveness and relative occurrence of the syllable structure in the world languages, where the simplest structure CV is easy to produce and occurs frequently and therefore is unmarked and acquired earlier than more complex structures.

An interesting aspect of OT is that it merges segmental form and prosodic phonology to express interactions between both. According to OT (Prince & Smolensky, 2008b), constraints are universal, but the rankings of these constraints are language particular. The two main types of constraints are: *markedness* constraints, which demand outputs to be structurally unmarked, and *faithfulness* constraints, which demand outputs to be faithful to their inputs whether these are structurally marked or not. For acquisition, the idea is that the learner needs to acquire the language-specific ranking of his or her mother tongue. The assumption here, like in most other work on acquisition to date (c.f. Gnanadesikan, 1995; Tesar & Smolensky, 1998), is that markedness constraints initially outrank faithfulness constraints. With regards to the

acquisition of syllable types, languages can be structurally marked or unmarked with respect to the markedness constraints that refer to syllable type, that is: ONSET, NO-CODA, *COMPLEX-ONSET and *COMPLEX-CODA. A language is structurally unmarked with respect to a markedness constraint when such a constraint dominates faithfulness, and it is marked when such a constraint is dominated by faithfulness (C. Levelt & van de Vijver, 2004). In phonological acquisition, the assumption is that the child's output is initially structurally unmarked (i.e., all the structural constraints dominate faithfulness constraints). The structural constraints that are relevant here are the following:

ONSET	A syllable should have an onset
NO-CODA	A syllable should not have a coda
*COMPLEX-ONSET	A syllable should not have a complex onset
*COMPLEX-CODA	A syllable should not have a complex coda

According to OT, the differences between languages can be represented as differences in the ranking of constraints (C. Levelt & van de Vijver, 2004). Structural constraints in a language allow outputs that are structurally marked in any possible way. When faithfulness constraint is ranked somewhere in between structural constraints, the language allows some complexity in output forms. OT merges the segmental form and prosodic phonology to express interactions between both especially when certain features align with word edges. However, it has the disadvantage that it does not restrict the possible interactions.

From the functionalist point of view, Davis and MacNeilage (1990) suggested that early emerging motoric bases for speech often dominate the production of early words, based on the 'frame and content' theory (MacNeilage & Davis, 2001; MacNeilage, Davis, Kinney, & Matyear, 2000). According to the latter view, the CV-associations found in babbling form compose the child's first words (i.e., labial consonants followed most often by central vowels, alveolar consonants by front vowels and velar consonants by back vowels).

McCarthy and Price (1995) introduced a hierarchy based on Selkirk's (1980) prosodic hierarchy. It consists of the prosodic word, foot, syllable and mora. The hierarchy expresses each level as a well-formed unit that descends from the level below: the prosodic word (PrWd) must consist of at least one foot (F), each foot must consist of at least one syllable (σ), and each syllable must consist of at least one mora (μ). The mora defines the syllable weight: the onset of syllable is discounted (it may consist of one or more consonants, or none), however, each vowel and any post-vocalic consonant of the rime counts as one mora, with a light syllable (L: one mora) and a heavy syllable (H: two morae, consisting of either VC or VV). Demuth and Fee (1995), within the framework of prosodic phonology, also suggested that first words conform to the minimal word constraint, such that early words are monosyllabic and minimally bimoraic: either (C)VV or (C)VC.

Drawing on the principles developed by McCarthy and Prince (1995), Fikkert (1994) proposed that children begin with a template defined by the default setting of all prosodic parameters. The focus of Fikkert's account was based on the internal structure of syllables and words and the principles of stress placement. For example, the child's template provides only for core syllable shape CV; as adult forms with clusters of coda consonants cannot be accommodated, they are deleted. When the target has two feet but the template only one foot; one foot may be selected and the other one is excluded. Fikkert (1994) takes the position that these aspects of language could not be derived 'lexically' or by simple exposure to input regularities; rather they must reflect the knowledge available to the infant through universal grammar. Rose (1997) criticized Fikkert's account and suggested that from a universal sonority scale (Rice, 1996), the child builds representations in order to encode the sonority contrasts that are present in his or her language. Rose (1997) claimed that the acquisition of segmental representations proceeds independently of, and in parallel with, acquisition of syllabic representations.

All theories of phonological development posit that the acquisition of syllable structures follows an orderly developmental course. For instance, Jakobson's structionalist account model calls for a 'universal' order; other formal models

that are based on prosodic theory claim that order is dependent on parameters of the sonority hierarchy. OT accounts for the interaction between two sets of constraints. In each of these diverse theoretical perspectives, emphasis is on how the nature of underlying representation and output rules (i.e., the child's competence) function to drive performance during acquisition of the adult sound system. Whatever governs the order of acquisition of syllable structures, developmental data often show a great deal of variability in order of acquisition - at least across languages - that may imply that there are other influential factors still need to be researched. The following sections will present evidence to support or reject few possible markers that are believed to influence the acquisition order of syllable shapes within and across languages.

1.5.1. Markedness

According to the markedness principle (discussed in section 1.4.1.), children's first words are typically simple in structure and content, reflecting the word shapes and segments that are most widely distributed in the world's languages, rather than the actual segments or word shapes in the adult target words (i.e., ambient language).

Syllable markedness is determined by two main parameters: segmental complexity and syllabic complexity (Jakobson, 1968). While the segmental complexity has been discussed in section 1.4.1 above, the focus of this section will be on syllabic complexity and its influence on the acquisition of syllable shapes. Based on the relative syllabic complexity scale, it is generally accepted to treat CV as the optimal syllable structure. It is the only syllable type that is present in all languages regardless of the maximal complexity of its onsets and rimes. When the onset (or rime is complex e.g., CC) the syllable is more marked. For example, CCVC is more complex than CVC and hence more marked. The increasing complexity of syllabic structure goes hand in hand with its relative markedness.

Different languages allow syllable types with different degrees of complexity. For example, Levitt & Van de Vijver (2004) found that some languages have only CV syllable types, while Dutch, like English, allows for a whole set of more

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complex syllable types. The one syllable type that all languages have in common is CV and this type is regarded to be totally unmarked. Data from Dutch-speaking children reported by C. Levelt, Schiller, and Levelt (1999) showed a specific order of development for the syllable types with a variation at one point: some learners acquired complex onsets before complex codas, whereas other learners acquired complex codas before complex onsets. This raises the question whether these are universal patterns of development or whether other learning paths are possible.

1.5.2. Phonological saliency

According to the sonority hierarchy discussed in section 1.4.2, stops are the lower sonority items and vowels are the higher ones. In between, the liquids and nasals appear in descending sonority levels. There seems to be an optimal ordering of elements with respect to a syllable peak across all languages (Yavaş, 1998). This relationship is shown schematically in figure 1.5.

On	Nu	Co
stop > fricative > nasal > liquid > vowel < liquid < nasal < fricative < stop		

Figure 1.5: The optimal ordering of elements with respect to a syllable peak (Yavaş, 1998).

The Nucleus (Nu) of the syllable is normally occupied by either a vowel or a diphthong, and the surrounding segments are composed of segments with lower sonority (Yavaş, 1998).

Syllables can be put on a continuum of naturalness or markedness based on relative sonority. For example, CV is the most unmarked syllable shape, as it is composed by one nucleus (high sonority) and one onset, whatever the value of the onset be, it is still relatively lower than CVC, which is more marked than CV.

The degree of markedness is often reflected on the acquisition of syllable shapes; for example Gnanadesikan (1995) showed that children's first syllables take the unmarked form of core syllables, or CV, also exhibiting a preference for the least sonorant onsets (least marked). Demuth (1996a, 1996b) and Demuth

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& Fee (1995) showed that children's early words take the unmarked form of a minimal word (CV) or binary foot. Pater (1997) added to these findings, showing that, when children truncate early words containing an initial unstressed syllable, they have a tendency to preserve the consonant that is least sonorant (less marked) in the onset position. Thus, although some children truncate *banana* to [ˈnænə], others select the word-initial stop (the least marked onset) to fill the onset of their truncated form [ˈbænə]. There is ample evidence that children in the early stages of acquisition produce unmarked syllable and prosodic word structures; and that segments influence the order of this acquisition (C. Levelt, Schiller & Levelt, 1999; Levitt & Van de Vijver, 2004). Based on these findings, it is possible then to assume that children are sensitive to the saliency of different syllable shapes.

Within the syllable structure, the sonority theory predicts consonants to appear in order of increasing sonority in syllable onsets, but the reverse order is true for syllable codas (the 'mirror effect') (Yavaş, 1998). For instance, in the English word *brand* [brænd] the relatively sonorous [r] and [n] are adjacent to the syllable nucleus with the less sonorous voiced stops appearing in the word's periphery. However, this prediction does not account for many commonly observed syllable structures. For example, the initial [sp], [st] and [sk] clusters runs counter to the prediction that syllable onsets are arranged in order of increasing sonority, and the final clusters such as [ps], [ts] and [ks] violate the rule of decreasing sonority towards the end of the syllable (Engstrand & Ericsdotter, 1999). It has been argued that the theory's central term, sonority, is empirically undefined (Ohala & Kawasaki, 1997). Attempts have been made to cope with this problem in terms of quantifiable dimensions such as the degree of jaw opening (Lindblom, 1983) or the amount of modulation in acoustic parameters (Kawasaki & Ohala, 2005). Although scales of sonority used by different researchers vary in detail, there is a general agreement on the relative sonority of different groups of sounds (Yavaş, 1998).

1.5.3. Input frequency

Children are sensitive to the high-frequency linguistic structures of the language(s) to which they are exposed (Kirk & Demuth, 2003; C. Levelt et al.,

2000). Kirk & Demuth (2003) found that error patterns made show an early preference for high frequency phonological structures in children's productions. This runs counter to the claims of Chomsky (1965) and Brown (1988) that frequency effects cannot explain the course of language development.

Just like segments, phonological structures are found to be sensitive to input frequency. For instance, Roark & Demuth (2000) showed that the earlier acquired structures in each language are much higher in frequency relative to other word and syllable structures. Accordingly, children tend to produce higher-frequency syllable shapes and prosodic word shapes before they produce lower frequency prosodic structures. Additional findings that are consistent with these claims are reported by developmental studies of Dutch-speaking children (C. Levelt et al., 2000) and Spanish-speaking children (Demuth, 2001). Roark and Demuth (2000) showed that the earlier acquired structures in each language are much higher in frequency relative to other word and syllable structures. Thus, children tend to produce higher-frequency syllable shapes and prosodic word shapes before they produce lower frequency prosodic structures. For example, Demuth (2001) found that Spanish-learning children tend to acquire initial weak (unfooted) syllables several months before English-learning children; equally, English-learning children acquire coda consonants several months before Spanish-learning children.

Similar findings were also reported by C. Levelt et al. (2000) study of Dutch-speaking children's development of syllable structure. The syllable shapes that are highest in frequency were found to be acquired first, and the syllable shapes that are lowest in frequency were acquired last. Interestingly, however, these children exhibited individual variation in the learning path when the frequency of two syllable structures was the same, some opting for increased complexity in the onset first (CCVC), and others exhibiting increased complexity in the coda first (CVCC). This suggests that we should expect to find individual variation when two comparable structures have equal frequency. C. Levelt et al. (2000) suggested that Dutch children are sensitive to the frequency of different syllable shapes and perhaps they are also sensitive to the markedness of these syllables (e.g., linguistic markedness such as syllables with added

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morphological value); or perhaps learning is facilitated when frequency and markedness coincide. Thus, the frequency of these different syllable shapes overlaps with markedness effects in the acquisition of phonology.

1.6. Conclusion

The influential factors briefly addressed above far from exhaust the range of proposals available in the literature. Nonetheless, they express relatively clear views of child phonology, with each factor highlighting crucial areas of consideration about child phonological acquisition. Factors that are believed to influence the course of phonological acquisition often face a number of relatively similar challenges. Phonological development is influenced by a variety of independent factors, whose combined effects yield a complex system that addresses language-specific as well as universal patterns.

In general, typological markedness across the world's languages may not be sufficient to explain the acquisition order of a language (Macken & Ferguson, 1983; Vihman, 1993). Therefore, more focus should be given to language-specific markedness to account for the order in which language-specific patterns are acquired. For instance, frequently occurring sounds in a language are believed to be more salient, easily articulated and are of high noticeability; hence it is expected they will be acquired early. Some researchers found that different acquisition order result from frequency differences across languages. However, as frequency of occurrence is language-specific it should explain the early acquisition of a phonetically marked sound, rather than cross language frequency (i.e., frequency of relative occurrence) (Van Severen et al., 2012).

The definition of influential factors varies between languages and it is difficult to apply their value across all languages (e.g., functional load, markedness, etc.). What makes a sound more salient in one language may not be applicable in other languages. For example, Pye et al (1987), who investigated the early acquisition of /ʧ/ by Quiché-speaking children, tried to explain the acquisition order from the concept of maximal opposition within the language which children try to build phonological contrasts, given that /ʧ/-/t/ opposition in Quiché is more salient and important than in English. It is, however, possible that both

language-specific factors and language universal factors have to be incorporated in the acquisition theory to be able to account for segmental developments in various languages.

The following chapter will present an overview of normative phonological development of Arabic- and English-speaking children in an attempt to identify universal and language-specific patterns. The chapter will also include a general discussion, based on the reported findings, to address methodological issues and variability during the course of development.

Chapter 2:

Normative studies on phonological acquisition

2. Chapter Two: Normative studies on phonological acquisition

This chapter provides background information on phonological acquisition through presenting relevant work from research in this area, with a focus on English and Arabic. Early developmental milestones will be discussed in detail with a special focus on early word production, and a discussion of current gaps in existing research on Arabic phonological acquisition.

2.1. Introduction

Cross-linguistic studies contribute to our understanding of language universals by comparing developmental patterns across different languages. A vast number of published studies exist on phonological acquisition yielding varying data and conclusions regarding normative acquisition of various languages. It is important to identify typical developmental patterns of children speaking their language or language pairs. Arabic and English languages have very different phonological and morphological structures, which make them great candidates for a crosslinguistic comparison of developmental data from both languages to contribute to our knowledge of universal and of language-specific patterns. The phonological inventories of the two languages overlap in the presence of certain consonants (e.g. /b, d, k, t, f/) and syllable shapes (e.g. CV, CVC). However, Arabic includes several additional consonants such as the emphatic consonants /tˤ, dˤ,ðˤ, sˤ/, voiceless uvular stop /q/, glottal stop /ʔ/, voiceless and voiced uvular fricatives /x/ and /ɣ/, and voiceless and voiced pharyngeal fricatives /ħ/ and /ʕ/ (Amayreh & Dyson, 1998); on the other hand, Arabic excludes the voiceless stop /p/ that occurs in English. At the syllable level, geminates, a wide variety of consonant clusters and morphophonological structures of Arabic play a vital role in the construction of word shapes. In Arabic, bound morphemes guide the formation of word shapes (for examples, please refer to section 2.3.3 of this Chapter and section 3.5.5 of Chapter 3).

The purpose of this chapter is to explore the available literature on child phonological development, focusing on normative phonological acquisition of Arabic- and English-speaking children. The chapter will evaluate

methodological differences that influence the reported findings in order to carry out a fair comparison between different languages.

2.2. Overview of major studies regarding phonological acquisition of English- and Arabic-speaking children

A review of normative studies of child phonological acquisition of Arabic- and English-speaking children was undertaken. Several major cross-sectional studies regarding the development of consonants between the ages 1;3 and 6;0 were selected. Relevant and available English and Arabic studies are listed in tables 2.1 and 2.3 below. The tables list sample sizes, age groups, study design, dialects and the acquisition criteria used for each study. The following subsections will summarise each study regarding the acquisition of English and Arabic phonology, respectively. The research findings and a methodological critique will follow, as well as a comparison between the reported findings in the developmental studies of Arabic and English phonology.

2.2.1. Normative studies on the phonological acquisition of English speaking children

This section will provide a brief summary of major cross-sectional normative studies on the development of English phonology. Because of the vast amount of literature available on the development of child phonology, only large-scale cross-sectional studies focusing on early acquisition of English phonology were selectively reviewed here in order to provide better comparative grounds with the findings of the current study. Table 2.1 presents a summary of normative studies focusing on the phonological acquisition of English speaking children; a brief overview of each study will follow.

Authors	Year	Lang.	*N.*	Age	Design	Focus	Criterion
Stoel-Gammon	1987	English USA	33	2;0	Cross-sectional	Consonants, clusters & syllable shapes	90%
Dyson	1988	English USA	20	2;0-3;3	Quasi-longitudinal	Consonants, clusters, syllable shapes & error patterns	At least two lexical items produced by at least 5 of the 10 children in the group
Smit et al	1990	English USA	997	3;0-9;0	Cross-sectional	Consonants & clusters	90%
Dodd et al.	2003	English UK	684	3;0-6;11	Cross sectional	Consonants & error patterns	90%
McIntosh & Dodd	2008	English Australia	62	2;1-2;9	Cross-sectional & Longitudinal	Consonants & error patterns	90%

Table 2.1: Major normative studies on the phonological acquisition of English speaking children

Stoel-Gammon (1987) collected conversational speech samples from 33 2;0-year-old monolingual English-speaking children. The samples were analysed to determine the word and syllable shapes produced, the inventories of initial and final consonantal phones and the percentage of correctly pronounced consonants. The study was based on an analysis of meaningful speech of those subjects who produced at least 10 different adult-based words during a 60-minute audio-recorded sample. The analysed corpus for each child contained a maximum of 50 words from the first 100 fully or partially intelligible utterances. In word-initial position, the stops /b, t, d, k, g/, nasals /m, n/, fricatives /f, s/ and glides /w, h/, and in word-final position, the stops /p, t, k/, nasal /n/, fricative /s/ and glide /r/ were acquired at the age of 2;0. Stoel-Gammon (1987) found that English-speaking children could produce words of the form CV, CVC, CVCV and CVCVC. There was no subdivision of the group of children to represent sequential development of sounds or syllable shapes.

Dyson (1988) reported findings of analysis of data collected from 20 English-speaking children. The subjects were divided into two groups (1;11-3;6; mean

age 2;0). Two spontaneous speech samples were audio-recorded approximately 5-6 months apart while the children played with a standard set of toys and objects at their day care centres. The analysis included word-initial and word-final phonetic inventories of consonant singletons and clusters. For the younger age group, the following were acquired between 2;0 and 2;5: in word-initial position, the stops /p, b, t, d, k, g/, nasals /m, n/, fricatives /f, s, h/ and glides /w, j, l/; and in word-final position, the stops /p, t, d, k/, nasals /m, n/, fricatives /f, s, ʃ/ and affricate /ʧ/. For the older age group, the following were acquired between 2;9 and 3;3: in word-initial position, all stops, nasals, fricatives /f, s, z, h/ and glides /w, j, l, r/; and in word-final position, all stops except /g/, all nasals, and fricatives /f, s, z, ʃ, v/. The study also provided a summary of the relative frequency of seven word shapes. The criterion used by Dyson (1988) differs from the one used by other researchers; a sound had to occur in at least two lexical items produced by at least 5 of the 10 children in a group. The overall percentages were not calculated, which is unfortunate as these figures would be useful when comparing the reported findings with other similar normative studies.

Smit, Hand, Freilinger, Bernthal, and Bird (1990) published normative data on the phonological acquisition of children of Iowa and Nebraska. It was a large-scale, multi-centre project that took place in two states in the USA. Subjects of this study were within 2.5 months of the target age for the age groups between 3;0 and 9;3. A single-word assessment tool was used to assess all English word-initial and word-final consonants. The outcomes of this study showed that early phonemes acquired between 3;0 and 3;6 are: /b, p, d, k, g, m, n, f, & w/; intermediate phonemes acquired between 4;0 and 5;0 are: /l, j, t, f, ð/; late phonemes acquired between 6;0 and 7;0 are: /θ, ð, ʃ, s, z, ʤ/; the rest were acquired by the age of 8;0-9;0 (/θ, ŋ, θ, r/). The authors also examined gender differences in the phonological acquisition patterns and reported a discrepancy in 10 out of 24 phonemes. Girls were able to master /t/, /d/, /θ/, /ð/, /ʃ/, /ʧ/, /ʤ/, /l/ and word-initial /j/ earlier than boys. Boys were able to master /n/ six months ahead of girls. The analysis also showed that word-initial /kw/ and /tw/ clusters normally appear in the speech of a child aged between 4;0-5;6. On the other hand, clusters such as /pl, bl, kl, gl, fl/ normally occur in the speech of a child

aged between 5;6-6;0.

Dodd, Holm, Hua, and Crosbie (2003) presented the largest study of its kind to provide extensive normative data for the phonological development of British English-speaking children. They assessed 684 monolingual English-speaking British children aged between 3;0 and 6;11; they were subdivided into nine groups and assessed at six-month intervals. An additional 32 children aged 2;0–2;11 were tested to supplement the normative data set on error patterns. Two aspects of speech development were considered: the age of the acquisition of sounds and the age that error patterns were evident. The criterion used to identify the age of acquisition was as follows: the sound had to occur in the speech of at least 90% of children within an age group. They found the following were acquired by the age of 3;5: all English stops and nasal as well as the fricatives /f, v, s, z, h/, glides /w, j/ and word-initial /l/. Between 3;6 and 3;11, the affricates /ʧ, ʤ/, and fricative /ʒ/ were acquired. Between 4;0 and 5;0, the fricative /ʃ/ was added to the inventory. /ɹ/ and both /θ/ and /ð/ fricatives were among the last sounds acquired after the age of 6;0. Error patterns significantly declined with age. Ninety percent of the assessed children over the age of 6;0 had error-free speech. Voicing had resolved by the age of 3;0, stopping by the age of 3;6 and weak syllable deletion and fronting by the age of 4;0. Deaffrication and cluster reduction was resolved by the age of 5;5 and liquid gliding persisted up until the age of 6;0.

McIntosh and Dodd (2008) evaluated the development of English phonology of younger children than those of Dodd et al's (2003) study. McIntosh and Dodd's study evaluated an assessment to determine if early identification of children with speech difficulties is possible and to establish normative data for children before the age of 3;0. They collected spontaneous speech samples of 62 children between the ages of 2;1 and 2;11. They found that children aged between 2;1 and 2;6 had acquired 10 sounds (m, n, p, b, t, d, k, g, s, w/) accurately in 90% of occurrences; while the older group (between 2;7 and 2;11) produced 6 additional sounds (/ŋ, z, f, l, j, h/) accurately in 90% of occurrences. The children's phonetic repertoires were missing / ʃ, θ, ʧ, ʤ, r /; and /ð, ʒ, v/ consonants were not assessed. Similar to Dyson's (1988) cross-sectional study,

the findings of McIntosh and Dodd (2008) also provide a snapshot of the course of phonological development at the age of 2;0 rather than a sequential process. The spontaneous speech samples of McIntosh and Dodd (2008) could possibly reflect the natural occurrence of a sound and its frequency, compared to the picture naming task used by Dodd et al. (2003).

The studies showed variable evidence for the age of acquisition of /ŋ, f, s, z, ʃ, ʒ/ (table 2.2). For example, in three out of five studies, the word-final /ŋ/ was reported to occur in the speech of children aged between 2;6 and 3;3 (Dyson, 1987; Dodd et al., 2003; McIntosh & Dodd, 2008). However, Smit et al. (1990) suggested that the correct realisation of this phoneme does not occur until children are aged between 7;0-9;0.

A summary of the reported findings is presented in table 2.2. The table shows that most studies agree that all English stops and nasals are acquired by the aged of 3;0, with the exception of Dyson (1988) who report earlier acquisition of stops due to their less stringent criterion for acquired sounds. Dyson's criterion allowed a wider range of variability in the determination of the age of acquisition. According to Dyson's criteria, five or more children in an age group should produce the sound to be identified. In terms of the number of occurrences, this may not satisfy the 90% criterion used by Dodd et al. (2003) and McIntosh and Dodd (2008).

	Stoel-Gammon (1987)		Dyson (1988)		Smit et al. (1990)		Dodd et al. (2003)	McIntosh & Dodd (2008)
Ages	2;0		2;0-3;3		3;0-9;0		3;0-6;11	2;1-2;9
5.1.1.1.	33		20		997		684	62
Data	Spontaneous speech		Spontaneous speech		Picture naming		Picture naming	Spontaneous speech
Consonant	Initial	Final	Initial	Final	Initial	Final	Initial & Final	Initial & Final
p		[50% at 2;0]	VE	VE	E	E	E	VE
b	VE		VE		E	E	E	VE
t	[50% at 2;0]	VE	VE	VE	E	E	E	VE
d	VE		VE		E	E	E	VE
k		[50% at 2;0]	VE	VE	E	E	E	VE
g	[50% at 2;0]		VE		E	E	E	VE
ʔ				VE				
m	[50% at 2;0]		VE	VE	E	E	E	VE
n	[50% at 2;0]	[50% at 2;0]	VE	VE	I		E	VE
ŋ				VE		L	E	VE
r		[50% at 2;0]	E		L			[<25%]
f	[50% at 2;0]		VE	VE	E	I	E	[75% at 2;1-2;5]
v				E	I		E	
θ					F: I; M: L		L	
ð					F: I; M: L		L	
s	[50% at 2;0]	[50% at 2;0]	VE	VE	L		E	VE
z				VE	L		E	[75% at 2;1-2;5]
ʃ				VE	F: I; M: L		I	[<25%]
ʒ							I	
tʃ				VE	F: I; M: L		E	[<25%]
h	[50% at 2;0]		VE		E			VE
dʒ					F: I; M: L		I	[<25%]
j			VE		I		E	VE
ɹ							I	
l			VE		I	F: I; M: L	E	[75% at 2;1-2;5]
w	[50% at 2;0]		VE		E		E	VE
Key:	Very Early (VE): 1;0-2;11		Early (E): 3;0-4;0		Intermediate (I): 4;1-6;4		Late (L): >6;4	

Table 2.2: Normative studies of phonological acquisition of English-speaking children

There is a general tendency for Smit et al. (1990) to report the age of acquisition as being older than that of the other aforementioned studies. The nature of Smit et al.'s study differs from the other studies under review, as it was designed to help speech therapists determine when intervention is required; therefore, the reported ages may denote the upper ages of tolerable speech errors rather than the ages of acquisition.

2.2.1.1. Reported findings on the development consonant clusters in English studies:

Three out of the five studies under review reported findings on the development of consonant clusters. Stoel-Gammon (1987) found that consonant clusters only occurred in 58% of the samples in word-initial position, and 48% word-final by the age of 2;0. Smit et al. (1990) found that by the time children reached the age of 6;0, at least 75% of them were using word-initial consonant clusters /Cw/, /sC-/, /Cl-/, and /Cr-/. Dyson (1988) found that, in word-initial position, one cluster /fw/ occurred in the speech of the younger group at the age of 2;0; also, in word-final position the /ts/ cluster occurred in the speech of children aged between 2;5 and 3;3.

2.2.1.2. Reported findings on the development word structures in English studies:

Two out of the five studies under review reported findings on the development of word structures. Stoel-Gammon (1987) found that, at the age of 2;0, all children were able to use CV and CVC monosyllabic word shapes. Disyllabic word shapes CVCV and CVCVC occurred less frequently. During all observations, Dyson (1988) found that children used more CVC words than any other type of words. The CV word shape was the second most frequently used shape up to the age of 2;9; at the age of 3;3. The fourth ranked word shape were two-syllable words, followed by VC words and V words.

The findings are summarised and presented in table 2.2; and will be further discussed below; the findings will be compared with those of the Arabic studies.

2.2.2. Normative studies on the phonological acquisition of Arabic speaking children

This section provides a summary of available studies regarding the acquisition of Arabic phonology. Table 2.3 below summarizes studies under review in this section. The findings of these studies will be summarised in table 2.3 below, followed by a discussion regarding the methodological issues.

Authors	Year	Dialect	N.	Age	Design	Focus	Criterion
Amayreh & Dyson	1998	Jordanian Arabic	180	2:0 - 6:4	Cross-sectional	Consonants	75%
Amayreh & Dyson	2000	Jordanian Arabic	13	1;2-2;0	Cross-sectional	Consonants, & frequency	75%
Dyson & Amayreh	2000	Jordanian Arabic	50	2;0-4;4	Cross-sectional	Error patterns	Produced by 5 out of 13 children in 2 different utterances
Ammar & Morsi	2006	Colloquial Egyptian Arabic	36	3;0-5;0	Cross-sectional	Consonants & error patterns	75%
Saleh, et al.	2007	Cairene Arabic	30	1;0-2;6	Cross-sectional	Consonants & error patterns	Produced by 5 or more out of 10 children in each group
Ayyad	2011	Kuwaiti Arabic	80	3;10-5;2	Cross-sectional	Consonants, clusters, syllable shapes & error patterns	90%

Table 2.3: Major normative studies on the phonological acquisition of Arabic speaking children

Amayreh and Dyson's (1998) study is the largest study of its kind in the field of Arabic child phonology. The subjects were Jordanian-Arabic speaking children aged between 2:0 to 6:4, with 10 boys and 10 girls in each of the nine groups. A 58-picture naming test was designed to elicit all possible standard Arabic sounds in all possible word positions. Children appeared to acquire /b, t, d, k, f, ħ, m, n, l, w/ between the ages of 2;0 and 3;10; /ʃ, x, ɣ, h, j, r/ between the ages of 4;0 and 6;4; and /tˤ, dˤ, q, ʔ, θ, ð, ðˤ, z, sˤ, ʕ/ after the age of 6;4. Interestingly, medial consonants were found to be significantly more accurate than initial and final consonants. The authors did not find significant correlation between word shape and stress of the syllable within which it occurred. This specific finding could be attributed to statistical artefact since both the stress pattern and consonant position within the syllable could influence the accuracy of its production. For example, a consonant that occurs in an unstressed syllable may be less salient and can be easily misperceived, thus produced in error or even omitted. Also, if the word-medial sound happens to be a geminate, which is common in Arabic, it is logical that the sound is more salient and acquired

earlier. It is important to note here that detailed analysis of word shapes is essential to provide a sufficient explanation for the development of error patterns and production accuracy.

On a later date, Amayreh and Dyson (2000) published a follow up study of 13 spontaneous speech samples from Jordanian Arabic speaking children between the ages of 1;2 and 2;0. 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; and the frequency of occurrence of vowels. They found that phonetic inventories composed of 50% stops, 16.9% fricatives, 12.5% glides, 11.6% nasals, 7.6% liquids and 1.8% affricates. The phonological inventories of children showed that children between the ages of 1;2 and 2;0 were accurately producing /b, t, d, ʔ, m, n, ʃ, ħ, ʕ, ʧ, h, j, l, w/; among those sounds /b, t, d, ʔ, m, j, w/ occurred most frequently in spontaneous speech. The authors claim that frequently occurring sounds are 'preferred' by the child. The preferred sound is more likely to substitute other less 'preferred' ones in a child's speech. However, the study did not examine error patterns to test the validity of this claim. Further examination of the data presented in Amayreh and Dyson's study could possibly explain this sound preference in terms of syllable shape in which it has occurred or other phonological components that influence the articulatory complexity of a less 'preferred' sound.

Dyson and Amayreh (2000) investigated phonological errors and sound change patterns in 50 typically developing Arabic-speaking children between the ages of 2;0 and 4;0. The authors used the same 58-word picture naming articulation test used in their earlier study (Amayreh & Dyson, 1998). The speech 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). Phonological error patterns were also examined. Findings of this study will be referred to below in the development of error patterns subsection (see section 2.3.3). It is important to note that this study's focus was on sound change as it relates to the ESA against which the children's

phonology was compared. The sample was of preschool-age children who were unlikely to use ESA in their everyday conversations. However, the authors did not explain the reason for examining their productions against ESA rather than casual speech (i.e., the Jordanian dialect of Arabic).

Ammar and Morsi (2006) studied the acquisition of Egyptian Arabic phonology of 36 typically developing children between the ages of 3;0 and 5;0; they were divided into two groups. The reported findings showed that Egyptian Arabic-speaking children acquire all consonants by the age of 4;0, except /dˤ, z, ɣ/ which are acquired between the ages of 4;1- and 5;0.

Saleh, Shoeib, Hegazi, and Ali (2007) studied the early phonological development of 30 Egyptian Arabic-speaking children between the ages of 1;0 and 2;6; they were divided into three groups in 6-month intervals. The relative frequency of occurrence of consonants in spontaneous child speech was calculated. It was found that children aged between 1;0 and 2;6 most commonly use the following consonants: /b, t, d, ʔ, m, n, j, w, h, s, l/. Although children aged between 1;0 and 2;0 were able to produce most Arabic consonants, only two consonants met the acquisition criteria of over 75% of children aged between 2;0 and 2;6 (/d/ 70% and /n/ 75%). The phonological repertoire of children in Saleh et al.'s study is rather limited in comparison to other studies; which is due to the age of the children who took place in this study being younger than those of other studies.

Ayyad (2011) conducted the first study on the phonological development of 80 Kuwaiti Arabic-speaking children between the ages of 3;10 and 5;2. Ayyad's study used the analytical model of the 'distinctive feature' theory (e.g., Jakobson and Halle, 1956), which examined sound acquisition in a set of binary acoustic, perceptual and articulatory features that differentiate one phoneme from another. The findings reported here are adapted to allow comparisons with other reviewed studies. In terms of segmental acquisition, the following consonants were acquired by the younger age group (aged between 3;10-4;5): /b, t, d, k, ɡ, q, ʔ, m, n, r, f, ðˤ, sˤ, x, ħ, ʧ, h, j, l, w/; the older group (aged between 4;6-5;2) added the following sounds to their phonological repertoire: /tˤ,

dˤ, f, ʃ, ɣ/. The following phonemes did not meet the 90% criterion for children aged 5;2: /θ, ð, s, z, ʕ, ʤ/. Interestingly, the younger group acquired the emphatic consonant /sˤ/ while its non-emphatic counterpart /s/ had not yet been acquired. The emphatic sounds are produced with secondary articulation in which the root of the tongue is retracted toward the back wall of the pharynx resulting in narrowing of the pharynx (Yavaş, 1998). According to the concept of articulatory complexity, one would expect non-emphatics to be acquired before complex emphatic consonants. However, other factors such as stress patterns or phonological saliency may influence the production of emphatics in certain environments. For example, if the emphatic sound occurs in a stressed syllable, this will make the sound more salient and noticeable, and therefore will be acquired earlier. These possibilities need to be explored in depth, especially given that emphatics are considered language specific characteristic of Arabic and some other Semitic languages.

The following section summarises the reported findings on the acquisition of Arabic consonants. The findings will be presented in tables 2.4 and 2.5 (below), followed by a discussion of the various methodological issues in relation to the reported findings.

The frequency of consonant occurrence reported by two studies, namely: Amayreh & Dyson (2000) and Saleh et al. (2007), and their findings of frequency of consonant occurrence are summarized in table 2.4. The token frequency of occurrence was calculated in both studies from children's spontaneous speech samples.

Amayreh & Dyson (2000)	Saleh et al. (2007)
Stops (50%): /ʔ/ > /t/ > /d/ > /b/ Fricatives (17%): /h/ > /ħ/ Glides (13%): /j/ & /w/ Nasals (12%): /m/ > /n/ Liquids (8%): /l/ Affricates (2%)	Stops (46%): /ʔ/ > /b/ > /t/ > /d/ Nasals (19%): /n/ > /m/ Fricatives (17%): /s/ > /h/ > / ħ / Liquid (9%): /l/ Glides (9%): /j/ > /w/

* "> " means more frequent than

Table 2.4: Frequency of token consonant occurrence in the speech of Arabic-speaking children

Table 2.4 illustrates that there is a general agreement on the most commonly used consonants between the two studies. Stops were among the highest ranked in both studies; however, the second ranked consonants differed. Amayreh & Dyson (2000) found that glides were the second most commonly used consonants, whereas nasals were second ranked in Saleh et al.'s (2007) study. The age groups in both studies are identical and both studies used similar analysis procedures. This discrepancy could be due to the difference in the study size or to the differences between Egyptian and Jordanian dialects of Arabic. Saleh et al's (2007) study was larger than Amayreh & Dyson's (2000; *N*= 30 and 13, respectively) and therefore could more accurately represent the frequency of occurrence in the Arabic-speaking children.

A comparison of developmental studies of Arabic phonology reveals significant anomalies. Despite differences in their sample size, elicitation methods, and criteria used in the analysis and findings, these studies have consensus on the status of some sounds. As shown in table 2.5 below, children tend to acquire less complex, coronal and more salient sounds (e.g., / b, t, d, m, n, ħ, j, l, w) before others (e.g., /r, x, tˤ, dˤ, θ, ð, ðˤ, s, z, ɣ, ʤ/). The studies showed variable evidence for the age of acquisition of /sˤ, ʃ, ʕ, h/ which could possibly be attributed to the methodological differences adopted by each study.

	Amayreh & Dyson (1998)	Amayreh & Dyson (2000)	Ammar & Morsi (2006)	Saleh, et al (2007)	Ayyad (2011)
Sample size	180	13	36	30	80
Age	2;0-6;4	1;2-2;0	3;0-5;0	1;0-2;6	3;10-5;2
Dialect	Jordanian	Jordanian	Egyptian	Egyptian	Kuwaiti
Data collection	Picture naming, single words	Connected speech	Picture naming, single words	Connected speech	Picture naming, single words
b	E	VE	E	VE	E
t	E	VE	E	VE	E
tˤ	L		E		I
d	E	VE	E	VE	E
dˤ	L		I		I
k	E		E		E
g			E		E
q	E				E
ʔ	E	VE	E		E
m	E	VE	E	VE	E
n	E	VE	E	VE	E
r	I		E		E
f	E		E		I
θ	I		E		
ð	L				
ðˤ	I				E
s	I		E		
sˤ	I		E		E
z	I				
ʃ	I	VE	E		
x	I		E		E
ɣ	I		I	VE	I
ħ	E	VE	E	VE	E
ʕ	I	VE	E	VE	
tʃ					E
h	I	VE	E		E
dʒ	I				I
j	E	VE	E	VE	E
l	E	VE	E		E
w	E	VE	E		E
Key:	Very Early: 1;0-2;6	Early: 2;7-4;0	Intermediate: 4;1-6;4	Late: >6;4	

Table 2.5: Normative studies of the phonological acquisition of Arabic-speaking children

These normative studies represent first efforts to examine the phonological repertoire and development of Arabic speaking children of various age groups. Variations exist between the sample size, age range of the subjects, elicitation techniques, criteria used and data presentation. It is important to review the weaknesses or concerns associated with these studies. Most concerns are related to methodological issues, particularly with regards to the criteria used.

As seen in table 2.5, there are differences in the age of acquisition with some sounds reported to be acquired early in one study and later in another. For example, the emphatic /tˤ/ was acquired earlier by children acquiring Egyptian Arabic (EA) compared to children acquiring Jordanian (JA) and Kuwaiti Arabic (KA). This could be due to a number of factors; first, the speech elicitation method was different in each study, and second, dialectal variations could possibly influence the frequency of the sound in the adult speech as well as the syllable structure in which the sound occurs. The fact that the dialectal variations of Arabic are poorly documented in the current literature makes it difficult to compare and contrast such a discrepancy. Several issues of concern are highlighted and discussed in detail below.

The first issue of concern with these studies is related to the speech elicitation process. The conflicting findings are most likely due to the extensive variability in the speech elicitation process or the criteria for acquisition used in these studies; or both. For example, Amayreh and Dyson's (2000) findings showed that the three sounds /ʃ/, /ʕ/ and /h/ were acquired by Jordanian Arabic speaking children between the age of 1;2-2;0. In contrast, these sounds were not yet acquired by the youngest age group (<2;0-3;10) reported in Amayreh and Dyson's (1998) study. Furthermore, the Arabic uvular stop /q/ was only reported by two studies; it is considered a phoneme that occurs in Modern Standard Arabic (MSA) and commonly used in the Kuwaiti dialect of Arabic. Ammar and Morsi (2006) as well as Ayyad (2011) agree that this sound is realised correctly between the ages of 3;0 and 4;0 and meet the 75% and 90% criterion, respectively. Amayreh and Dyson (1998) found that the /q/ sound is present in the child's phonological repertoire even before the age of 2;0, however, it did not appear spontaneously in the younger age groups examined by Amayreh and Dyson (2000). Ammar and Morsi (2006) as well as Ayyad (2011) constructed picture-naming tests to elicit speech sounds, whereas Amayreh and Dyson (2000) analysed spontaneous speech samples, which is more likely to represent the child's phonological repertoire.

Another issue is the difference in the children's ages in each study; children in Amayreh and Dyson's (2000) study were younger than the children in the other

two studies. This may as well influence the reported findings. Children aged 2;0 may have limited lexical knowledge and therefore may not possess an adequate vocabulary to express the /q/ sound in spontaneous speech. Not surprisingly, different data elicitation procedures and the criteria used in these two studies, was reflected in the age of acquisition of sounds. Ammar and Morsi (2006) and Ayyad (2011) used picture-naming tests to collect speech samples, whereas Amayreh and Dyson (2000) study collected data through spontaneous connected speech. The spontaneous speech sampling method used in the current study provides valuable information on the natural occurrences of phonemes in children's speech. With this method, the child's speech is not restricted to a set of words that may or may not reflect the sounds, word structures and shapes that occur in natural speech.

The influence of target words used in word lists (i.e., syllable structure and word shape frequency) may result in the occurrence of an error or may create a statistical artefact especially if a certain syllable structure or a segment occurs more frequently than others. Does the occurrence of a syllable structure reflect the natural frequency of such structure in the child's speech? This may be difficult to know for sure due to a lack of documentation regarding the frequency of occurrence of speech sounds in Arabic in general and its various dialects.

The second main issue is related to the dialectal variability of Arabic across the Arab world. Ayyad's (2011) study is the first study to explore the Kuwaiti dialect of Arabic. All previous studies were concerned with other Arabic dialects such as Egyptian (Ammar & Morsi, 2006) and Jordanian (Amayreh & Dyson, 1998, 2000, 2003). Dialectal differences and the influence of language mixing in different parts of Arabic speaking communities are often reflected in the phonological repertoire of Arabic-speaking children. For instance, the Kuwaiti dialect of Arabic includes the /ʧ/ sound as an allophony of /k/ in certain contexts (see section 3.5.1 of Chapter 3 for details). This sound does not occur in either Egyptian or Jordanian Arabic and was not reported in any of the studies listed above, except Ayyad's (2011) study of Kuwaiti Arabic. The multilingual situation of Kuwait and trend of language code-switching coupled with the extensive use of English among the younger generations of Kuwait; leads to a wider repertoire

of sounds by Kuwaiti speakers, which includes non-native sounds like /p/ and /v/.

Ayyad's (2011) study was designed to examine the Kuwaiti dialect of Arabic rather than MSA; as children in Kuwait are not usually exposed to MSA until they begin school at the age of 5;0. The word lists were carefully designed to reflect the spoken dialect in Kuwait by most preschoolers. However, the author expressed some difficulties in eliciting several words contained in the list. Some tokens were elicited by imitation when children were unable to produce the target word with all the bound-morphological features. This may reflect the complex morphology of the Arabic language in general, and may also limit the naturalness of the data elicitation process. For instance, the child's speech may lack many morphological markers yet still be intelligible and acceptable in daily communication; however, this would greatly influence the shape (or structure) of target words.

Picture-naming is a commonly used method to explore the full phonological profile of children. This method has its advantages and disadvantages. It may exhibit all possible phonological segments and word structures of a spoken language; however, it may also limit children's abilities when they are unable to name a picture. Moreover, word frequencies in Kuwaiti Arabic are not yet documented in the literature; this may influence Ayyad's (2011) choice of words and word lengths that are used in the elicitation method. The word choice may or may not reflect the natural occurrence in the Kuwaiti dialect of Arabic (in both adult and child speech). The current study attempts to avoid such limitations by employing a more naturalistic method of data elicitation whereby the child's abilities are less likely to be restricted.

The third issue of concern relates to sample size and age group stratification. Differences in the age range of subjects studied resulted in the appearance of an earlier age of acquisition in the reported data. For example, Saleh, et al. (2007) found that most 'early' sounds reported by both Amayreh and Dyson (1998) and Ayyad (2011) are acquired by the age of 2;0 despite the notable variation in the criteria for the age of acquisition used by all three studies.

Several studies grouped children in 6-months age intervals (e.g., Ayyad, 2011) or 12-months age intervals (Ammar & Morsi, 2006; Saleh et al., 2007), which may not be narrow enough to capture the phonological growth that takes place in children younger than the age of 3;0 (Watson & Scukanec, 1997). This wide-range stratification may not capture the linguistic development before the age of 2;0. Therefore, in the current study, children are grouped in 3-months age range intervals in order to obtain detailed phonological profiles of children between the ages of 1;4 and 3;7.

The final issue of concern relates to the analytical procedures used in each study. The differences in criteria for the age of acquisition may also influence the reported findings. Amayreh and Dyson's (2000) criterion of acquisition was that a sound has to occur in the speech of five out of thirteen children, in at least two different utterances. In contrast, Amayreh & Dyson (1998) used a 75% criterion for sound acquisition. For example, Amayreh and Dyson (2000) determined the phonetic inventories of consonants for all children in all word positions (initial, medial and final). The authors compared the ranked frequency of occurrence of consonants in child and adult speech. The results showed an evident influence of the ambient language on the route of development, with /l/ and /j/ developing earlier in Arabic-speaking than English-speaking children. Amayreh and Dyson did not analyse the articulatory complexity of consonants but argued that the earlier emergence of /l/ and /j/ reflected the high frequency of occurrence of these segments in the ambient language; however, no statistical analysis was reported to support their claim.

Amayreh and Dyson (1998) defined three types of age of acquisition, taking into consideration both individual variation and group trends. Three levels of sound acquisition were defined: 'age of customary production', in which at least 50% of children in an age group produce the sound correctly in at least two positions; 'age of acquisition', in which at least 75% of children in an age group produce the sound correctly in all positions; and 'age of mastery' in which at least 90% of children in an age group produce the sound correctly in all positions. Three out of six of the studies considered a phoneme acquired when 75% of children of an age group met the criteria. Only one study (Ayyad, 2011) considered a

feature acquired when 90% of children of an age group met the criteria. This variability in criteria of acquisition impacted the reported findings. Among the six studies, the findings of Amayreh and Dyson (1998), Ammar and Morsi (2006) and Ayyad (2011) are most similar: the same age of acquisition was reported for 12 sounds (/b, t, d, k, ʔ, m, n, ɣ, ħ, j, l, w/), with a difference of one year on eight sounds (/q, r, θ, s, sˤ, ʃ, x, ʕ, h) and a difference of two years on three sounds (/tˤ, dˤ, f/).

Furthermore, Amayreh and Dyson (1998) and Saleh et al. (2007) both shared similar criteria for the age of acquisition and speech elicitation processes. The youngest group of children that have been studied are those aged 1;0 (Saleh et al. (2007) and 1;2 (Dyson & Amayreh, 2000), however, the criteria used was set at approximately 50% and 38%, respectively. While this low-cut off criterion may offer a more comprehensive view of children's abilities, it does not provide accurate boundaries for the development stage of a given sound.

2.2.2.1.   Reported findings on the development of consonant clusters in Arabic studies:

Ayyad (2011) found that words with syllable-initial clusters were not acquired across Kuwaiti-Arabic speaking children before the age of 4;0, further, words with both codas and clusters were particularly challenging. Ayyad found that children between the ages of 3;10 and 4;5 met the 90+% criterion for the acquisition of one cluster only, namely /fl/ in /fluːs/ 'money'. The consonant cluster /xj/ in the word /xjutˤ/ 'threads' was acquired by at least 75% of children. The initial /xj-/ cluster was often elicited with direct imitation in Ayyad's study. Other clusters that showed 75-89% acquisition were /bj-/, /sm-/ and /xʃ-/. Again, these were frequently elicited with delayed imitation, which may have influenced the outcomes. Moreover, both /bj-/ and /sm-/ clusters had early-acquired consonants, and the uvular cluster showed few errors (xj-). For word-final position, the following were acquired in terms of structure: /-rd, -lb, -ldʒ, -jl, -ltʃ/.

2.2.2.2.   Reported findings on the development of word structures in Arabic studies:

Syllable structures and word shapes of the Arabic language (and its dialects) are poorly documented in the literature. For the Egyptian dialect of Arabic,

Ammar, (2002), Ammar and Morsi (2006) and Ragheb and Davis (2010) all agreed that 90% of all possible Arabic word shapes are acquired between the ages of 2;0 and 3;0. They suggested that complex words occur fairly early in Arabic. Ayyad's (2011) analysis provided a rather detailed profile of the development of word shapes in Arabic compared to earlier studies. Ayyad (2011) found that the monosyllabic word shapes: CVV, CVC and CVCC were acquired by more than 90% of children between the ages of 3;10 and 5;2. However, Ayyad reported that only one consonant cluster was acquired in word-final position by the age of 4;0 which contradicts the 90% acquisition of CVCC. This could be due to the picture-naming assessment tool that has been used in the study, which may not represent all types (or tokens) of coda clusters of KA. Thus, codas, diphthongs and final clusters were acquired, however, initial clusters were still showing a developmental pattern. Ayyad suggested that initial clusters hold high-ranked constraints, reflecting their complexity. Disyllabic word shapes: CVCV (e.g., /ˈdu.wa/ 'medicine'), CVVCV (e.g., /ˈmo:.za/ 'banana') and CVCCV (e.g., /ˈʔar.nəb/ 'rabbit') were acquired by more than 90% of all children in Ayyad's study. Most multisyllabic word shapes were acquired by more than 90% of the older group of children (aged between 4;6-5;2), whereas the younger age group (aged between 3;10-4;5) were still acquiring multisyllabic words with the shapes CVCVCV (e.g. /sˤa:.bu:.na/ 'soap'), CVCCVCVC (e.g., /ʔim.ˈka.s:ar/ 'traditional pants'), CVCVCVCV (e.g., /tu.f:a.ˈxi.j:a/ 'baloon'), and CVCCVCVCV (e.g., /bur.tə.qa:.la/ 'orange'). Further statistical analysis showed that all deletions by word shape were significantly fewer in the older group. It is important to note here that Ayyad's transcription of word shapes did not account for geminates, vowel length or syllable markers. For example, the word shape of /sˤa:.bu:.na/ 'soap' was CVCVCV according to Ayyad's transcription, however, in the current study the shape of this word transcribed as CVV.CVV.CV.

The next section will discuss the development of error patterns in Arabic and English languages and the analytical methods adopted by this study.

2.3.   The development of error patterns

Phonological systemacity is often described in the period following first word production, as children begin to accommodate adult forms beyond their production constraints; at this stage, the child begins to make systematic changes in the reproduction of adult segments, sequences and syllables or word shapes (Ingram, 1989b; Grunwell, 1981). These changes are often described as phonological patterns and are prone to a great deal of variability within and across groups of children (Vihman, 2014).

Early studies of child phonological acquisition served different theoretical frameworks and accordingly, used different descriptive terms. For instance, phonological 'rules' (Ingram, 1974, 1992; Menn, 1971; Smith, 1973) or 'processes' (Oller, 1980; Stampe, 1969) were described by using different terms. According to Stampe's (1969) theory of natural phonology, these rules are universal and innate 'phonological processes' and can be applied to both adult and child speech. Stampe claims that children must learn to suppress those processes that do not occur in their language in order to develop an adult-like phonological system. In contrast, Smith (1973) assumes that these processes, which he refers to as '*realisation* rules', are rather simplified and ultimately unlearned in the course of development. The original concept of phonological processes was widely criticized because both Smith and Stampe's views lacked psychological reality or explanatory power (for further details, see Bankson & Bernthal, 1998). However, in the field of developmental phonology, the general consensus is that phonological processes are the most economical way of describing the relationship between adult targets and a child's production. Dodd et al. (2003) defined phonological processes as 'a set of mental operations that change or omit phonological units as the result of the natural limitations and capacities of human vocal production and perception' (p. 623). In order to avoid the theoretical assumptions associated with phonological processes, this study will follow Dodd et al.'s (2003) approach and refer to *error patterns* rather than phonological 'processes' or 'rules'.

2.3.1. Phonological error patterns: methodological differences

Undertaking a comprehensive comparison between all normative studies reporting the development of error patterns is challenging for two main reasons: first, the methodological differences between the studies (e.g., identification criteria, statistical calculations); second, variable use of terminology to describe error patterns.

Regarding methodological disparities, different studies have used different analytical procedures and criteria for pattern identification; these disparities impacted the presentation of reported findings. For example, Dyson & Amayreh, (2000) and Ammar & Morsi (2006) reported findings in the form of percentages of occurrence, while Ayyad (2011) reported the numbers of occurrence of an error pattern, which was counted as present. Additionally, Dyson & Amayreh's (2000) criterion for error pattern identification differs significantly from the one used by Ammar & Morsi (2006). Dyson & Amayreh (2000) identified an error pattern as present if it occurs in at least 5% of the possible occurrences in an age group. Ammar & Morsi (2006), on the other hand, identified an error pattern as present if it occurs in at least 25% of the possible occurrences in an age group. Dyson & Amayreh's low cut off point allowed wider variation in error patterns compared to the one used by Ammar & Morsi, in which only one error pattern met the 25% identification criterion. Therefore, a higher percentage of occurrence could mask a great deal of what is actually produced by the child.

Similarly, researchers examining developmental patterns in the speech of children learning English used different criteria. For example, the pattern identification criteria used by Dodd et al. (2003) and McIntosh & Dodd's (2008) normative studies of English-speaking children differs significantly. In the former study, the pattern was identified as present if it occurs in the speech of more than 10% of children in an age group, and the error pattern has to occur five or more times; while in the latter, a pattern has to occur in at least two different lexical items to be identified as present in an age group. This variability in identification criterion used by different researchers makes it impossible to perform a direct comparison of error that occurs in the speech of children

learning the same language. The criteria used by McIntosh & Dodd is relatively more lax compared to Dodd et al's; this could be the reason why one error pattern (voicing) was reported by McIntosh & Dodd yet not captured by Dodd et al's criterion.

2.3.2. Phonological error patterns: definitions

Researchers often use different terms to describe error patterns, which in turn complicate the process of direct comparison within and across languages. Looking at the studies under review, fronting and dentalization terms are used interchangeably to describe error patterns that involve place of articulation. For example, Dyson and Amayreh (2000) described fronting patterns (e.g. /k/→[t] and /q/→[g, k, d, t]) and dentalization patterns (e.g., /s/→[θ]) as two distinctive categories. The difference between the two patterns was that the term fronting was used to describe velar and uvular sound changes whereas the term dentalization was used to describe nasal and liquid sound changes, both referring to change in place of articulation to an anterior position. Likewise, dentalization error patterns were only reported by studies of Arabic-speaking children (e.g., Dyson & Amayreh, 2000; Ayyad, 2011), and the same error patterns were referred to as fronting in studies of English-speaking children (e.g., Dodd et al., 2003 & McIntosh & Dodd, 2008). Studies of both languages described the same pattern, but used different terms to report the findings. Similarly, different researchers used the terms stridency deletion, substitution and stopping of fricatives interchangeably. For instance, Dyson and Amayreh (2000) reported that strident consonants are often deleted (e.g., dˤif.dˤaʕ/→ [duː.daʕ]) or substituted with non-strident (e.g., /sa.ma.ka/→[ta.ma.ka]). The latter error pattern, strident substitution, was described as stopping by other researchers, such as Dodd et al. (2003) and McIntosh & Dodd (2008). Therefore, it is important to clarify the definitions used by different researchers in order to examine the similarities and differences in error patterns that occur in different languages.

The definitions of error patterns used in the current study are selectively adapted from Ingram (1989b), Grunwell (1981) and Amayreh and Dyson

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(2000). Patterns described here are divided into two main subsections: segmental and prosodic patterns (listed in tables 2.6 and 2.7 below). It is important to note that, in this section and throughout, transcriptions between slash brackets represent adult-like, target forms, and arrows indicate correspondence between adult target forms and child realisations.

a. Segmental patterns:

At the segmental level, a number of systematic discrepancies between child and adult pronunciations have been documented. Segmental patterns are those changes that occur by the substitution of one sound for another with the replacement sound reflecting changes in place of articulation, manner of articulation, or some other change in the way a sound is produced in standard production. The segmental patterns, such as those in table 2.6, are often context-sensitive, varying across segmental and prosodic contexts (Rvachew & Andrews, 2002). There is considerable variability across specific error pattern analysis procedures with respect to the treatment of syllable position when determining the frequency of occurrence of segmental processes (i.e., those that involve substitutions, such as velar fronting or stopping of fricatives).

1) Segmental patterns	Definition	Example(s)
Place		
Fronting (including dentalization)	Substitution are produced anterior, or forward of, the standard production place	/k/→[t] or [d] /g/→[d]
Backing	Sounds are substituted or replaced by segments produced posterior to, or further back in, the oral cavity than the standard production	/t/→[k] /d/→[g]
Manner		
Stopping/spirantization (including stridency substitution)	Realizing fricatives or affricates as stops/Realizing stops as fricatives, including strident substitution with a non-strident	/s/→[t] /t/→[s] /'sa.ma.ka/→['ta.ma.ta] 'fish'
Gliding/rhoticisation	Prevocalic liquids are replaced by vowels	/r/→[w] /w/→[r]
Devocalisation/vocalisation	Liquids or nasals are replaced by vowels	/j/→[l] /ɬ/→[u]
Denasalisation/nasalisation	Nasals are replaced by homorganic stops" (i.e. sharing a similar place of articulation to the target sound)	/m/→[b] /b/→[m]
De/affrication	Affricates are replaced by fricatives	/ʧ/→[ʃ] /ʃ/→[ʧ]
Glottal replacement	Glottal stops replace sounds usually in either intervocalic or final position	/q/→[ʔ]
De-emphasis	The loss of the secondary articulation for emphatic consonants	/sˤ/→[s]
Stridency deletion	The deletion of fricatives or affricates	/ʃ/ or /ʧ/→ ∅ /'dif.dˤaˤ/→['dˤu:.dˤaˤ] 'frog'
Lateralisation	The substitution of [l] for /r/	/r/→[l]
Voicing		
Devoicing/voicing	Voiced consonants are replaced with voiceless or vice versa	devoicing: /b/ → [p] voicing: /p/ → [b]

Table 2.6: Segmental error pattern definitions

b. Prosodic patterns:

Systematic discrepancies between adult and child productions are also observed in the prosodic domain, i.e. syllable structure, word shape, or the location of stress or tone (table 2.7).

2) Prosodic patterns	Definition	Example(s)
Affecting syllables:		
Coda deletion	Deletion of the final consonant in a syllable/word	/kat/→ ka]
Cluster simplification/reduction	Simplification of consonant, for example, the cluster can be reduced to one member of the consonant cluster, the entire cluster can be deleted, another sound can be substituted for the entire cluster, one member of the cluster is retained and a sound substitution is made for the other member of the cluster. Features from both members can also be combined so that one sound replaces two other sounds (coalescence)	/skiː/→[kiː]/[siː] /pleɪ/→[peɪ]/[leɪ]
Right-edge cluster reduction	Simplification of coda clusters	/tɛnt/→[tɛn]/[tɛt]
Consonant/glide epenthesis	Addition of consonant or glide to a syllable structure	/sˤba.ˈjːaːn/→ [sˤɔ.ba.ˈjːaːn] 'boys'
Affecting word shapes:		
Unstressed syllable deletion	Deletion of an unstressed syllable (weak syllable deletion)	
Syllable reduplication	A syllable or a portion of a syllable is repeated or duplicated or a portion of a target (monosyllabic) word is repeated (e.g. CV or CVC → CVCV syllable utterance)	bottle [bɒ.bɒ], blanket [babə]
Metathesis	Reordering or transposition of the consonantal elements of the target word	/dʒduːr/→[dʒruːd] *'pots'*; /xʃuːm/→[ʃxːm] *'noses'*
Stress shift	Applying stress to different word segments compared to the target word	/dʒəˈɹæf/→[ˈdʒiːɹæf]

Table 2.7: Prosodic error patterns definitions.

Generally, prosody often links semantic information, syntactic and morphological structure as well as segmental sequences into a consistent set of address frames like syllables, metrical feet, phonological word and intonation phrases at different levels of the prosodic hierarchy (C. Levelt et al., 2000). In phonology, the prosodic error patterns are context-sensitive in most languages. In English, the phonetic realisation of segments largely depends on their position with respect to stress. For example, stressed vowels preserve full vowel quality, while the same vowels in an unstressed position will be reduced to [ə] or the reduced vowels [i, u] (e.g. *'present* ['prezənt] vs. *pre'sent* [pri'zənt]). Likewise, children learning English often delete the unstressed syllable in multisyllabic words (Ingram, 1989a; Grunwell, 1981). The unstressed syllable is less salient in the adult's speech and therefore is less noticeable; it is also less marked when phonological saliency is used to measure the markedness of the segment. According to the markedness notion, unmarked segments are susceptible to sound changes or deletion. Further examples will be discussed

below following a brief overview of common error patterns that occur in the speech of children learning English and Arabic.

The development of error patterns in the child's speech is sensitive to the ambient language. Researchers studying the sound changes observed in normally developing children learning a variety of languages have reported similar error patterns among children learning different languages. For example, D. Mowrer and Burger (1991), studying Xhosa, and So and Dodd (1994), studying Cantonese, reported that most processes and sound changes occur in English as well as in the languages they studied (e.g., fronting, stopping and cluster reduction). This similarity in error patterns suggests that certain sounds, sound classes and contexts may pose difficult physiological (i.e., articulatory complexity) and perceptual tasks (i.e., phonological saliency) for children learning any language (Winitz,1969; Locke, 1983; D. Mowrer and Burger, 1991). Differences among error patterns may reflect the phonology of the ambient language (Ingram, 1989a; Pye et al., 1987; Bortolini & Leonard,1991). Some error patterns are believed to be specific to a language or to language groups (So and Dodd, 1994) and often affected by language specific markers such as frequency of occurrence and functional load (Ingram, 1989a, 1989b). The influence of markedness, phonological saliency, frequency of occurrence and functional load will be discussed towards the end of this section; also, a review of error patterns reported in Arabic and English normative studies will be presented.

2.3.3. Phonological error patterns: normative studies

Cross-linguistic studies compare the emergence of error patterns in the speech of children learning Arabic with that of children learning English in order to identify universal and language specific trends that have significant influence on the development of error patterns within and across languages (Dyson & Amayreh, 2000; Ayyad, 2011). A cross-linguistic comparison of the occurrence of error patterns in the developing child's speech provides a valid insight into how the child phonological system unfolds. Error patterns observed in the two languages could also explain some aspects of developmental universality. A number of parameters used to measure phonological markedness, such as

articulatory complexity and phonological saliency, account for the order of consonant acquisition and could possibly influence the development of error patterns in the child's speech.

This section will discuss reported findings on the development of error patterns in four studies which were reviewed above (Arabic: Dyson & Amayreh, 2000; Ammar & Morsi, 2006; Ayyad, 2011; English: Dodd et al., 2003; McIntosh & Dodd, 2008). A brief overview of the challenges in performing direct comparisons will be provided along with a review of the significant findings of each study. This section will also address, as much as possible, the potential factors affecting the development of error patterns such as markedness, phonological saliency, frequency and functional load. The findings reported in table 2.9 (below) are based on error patterns defined in tables 2.6 and 2.7 above. It is important to note the differences in the identification criteria used in each study (see table 2.8); and the reported findings listed in the table were based on the identification criteria used by the original study. Table 2.8 (below) illustrates the different identification criteria adopted by the studies under review.

	Language/dialect	Error pattern identification criterion
Dodd et al (2003)	English/UK	More than 10% of children in an age group had to exhibit the error pattern ≥ 5 times (≥2 times for weak syllable deletion)
McIntosh & Dodd (2008)	English/USA	At least 2 occurrences in different lexical items
Dyson & Amayreh (2000)	Arabic/Jordanian	Reported each pattern independently (range 25%-50%)
Ammar & Morsi (2006)	Arabic / Egyptian	25% of occurrences
Ayyad (2011)	Arabic/ Kuwaiti	Required only one occurrence (feature analysis)

Table 2.8: Error pattern identification criterions used in studies phonological development studies

As shown in table 2.8, different criteria were used for phonological error pattern identification; this difference should be carefully considered while comparing the reported findings. For instance, Ayyad (2011) required only one occurrence to count the occurrence of an error pattern in a child's speech, while Dyson and

Amayreh (2000) and Ammar and Morsi (2006) used criteria that ranges from 25% to 50% of occurrences for a process to be counted. This variability in the criteria used to report the development of phonological process complicates the process of comparing outcomes, and consequently, the clinical applicability of the reported outcomes.

The findings of normative studies under review are summarised in table 2.9 below. Despite the differences in criteria used by the different researchers, there are several error patterns that occur in the speech of children learning English that are also evident in the speech of those learning Arabic. Several influential factors, such as phonological markedness, may explain the occurrence of such error patterns in two distinctive languages such as Arabic and English.

Since English and Arabic differ phonetically and phonologically, the differences in acquisition may be due to variations in the phonetic detail of the consonants, such as articulatory complexity, their perceptual characteristics and the frequency of occurrence. A number of differences in acquisition were observed between these two languages in studies regarding the development of English and Arabic phonology.

Language	English						Arabic					
(1) Segmental patterns	2;0-2;5	2;6-2;11	3;0-3;5	3;6-3;11	4;0-4;5	4;6-4;11	2;0-2;5	2;6-2;11	3;0-3;5	3;6-3;11	4;0-4;5	4;6-4;11
a. Place												
Fronting	E	E	E	E			J	J	J			
Dentalization									J	J	K	K
a. Manner												
Stopping (including stridency substitution)	E	E	E				J	J	K	K	K	K
Spirantization							J	J	K	K		
Gliding	E	E	E	E	E	E						
De-affrication	E	E	E	E	E	E						
De-emphasis							J	J	J K	J K	K	K
Stridency deletion							J	J				
Lateralization							J	J	J K	J K	J K	K
b. Voicing												
De-voicing							J	J	J E	J E		
Voicing	E	E										
Glottalization							J	J				
(2) Prosodic patterns												
a. Affecting syllables:												
Coda deletion	E	E							K	K		
Cluster simplification	E	E	E	E					E K	E	J K	
b. Affecting word shapes:												
Weak syllable deletion	E	E	E				J	J	E K	K	K	J
Metathesis									K	K		
Epenthesis									K	K	K	K
Key:		Satisfied the identification criterion used in the original study				Did not satisfy the identification criterion used in the original study						

Note: **E: English** (Dodd et al., 2003; McIntosh & Dodd, 2008)) **J: Jordanian-Arabic** (Dyson & Amayreh, 2000); **K: Kuwaiti-Arabic** (Ayyad, 2011); **E: Egyptian-Arabic** (Ammar & Morsi, 2006)

Table 2.9: Developmental error patterns produced by English- and Arabic-speaking children

As seen in table 2.9, there are a number of error patterns that occur in the speech of monolingual children acquiring Arabic or English. At the segmental level, two common patterns were reported to occur over the course of acquisition: fronting and stopping. At the prosodic level, three common patterns were observed in both languages; coda deletion, cluster simplification and unstressed syllable deletion.

Stopping error patterns have been observed in the speech of children learning both Arabic and English (see table 2.9). This error pattern refers to the

substation of fricatives or affricates with stop sounds (Ingram, 1989a). Based on the articulatory complexity parameter of markedness, fricatives are less marked than stops in English (Stokes & Surendran, 2005) and Arabic (Dyson & Amayreh, 2000); further, they are more prone to erroneous production compared to stop consonants. As illustrated in table 2.9, stopping error patterns occur in the speech of English-speaking children and resolve by the age of 3;11; on the other hand, stopping takes a year longer to resolve in the speech of children learning Arabic (up to the age of 4;11). This variation in the rate of development could possibly be due to difference in the articulatory complexity of fricative consonants. It is important to note that the Arabic has more fricatives than English, that is, four additional fricatives /x, ɣ, ʕ, ħ/, and two emphatic fricatives /ðˤ, sˤ/ which are exclusive to Arabic. Emphatic consonants are classified among the 'difficult' sounds in that they have two simultaneous places of articulation (Ladefoged & Disner, 2012; Shahin, 1996, 2006). The presence of emphatic sounds in Arabic adds to the articulatory complexity parameter of the non-emphatic fricatives that are shared with English (f, v, θ, ð, s, z, ʃ, h/).

Frequency of occurrence may also play a role in the development of Arabic emphatic consonants. Amayreh, Hamdan and Fareh (1999) calculated the frequency of occurrence of consonants in spontaneous speech samples of 13 Arabic-speaking children aged between 1;2-2;0. They found that among the 28 Arabic consonants, the five emphatic consonants ranked between 20th and 27th, together accounting for approximately 6% of the consonants used. In support of the influence of frequency on production accuracy, Stokes and Surendran (2005) found that the frequency of occurrence and functional load are likely to influence the consonant production accuracy of children learning English between the ages of 0;8 and 2;0; after this age, accuracy was found to be more sensitive to the articulatory complexity of English consonants. Furthermore, as Arabic emphatic sounds are generally acquired late (Amayreh & Dyson, 2000; Ammar & Morsi, 2006, Saleh et al., 2007), and are expected to be subject to substitutions during the early stages of development (Amayreh, 2003). Late acquisition of some consonants may explain why Arabic-speaking children still produce this error pattern for a year longer compared to English-speaking children.

Table 2.9 also shows that unstressed syllable deletion occurs in the speech of children acquiring Arabic and English. However, this type of pattern resolves earlier in the speech of children learning English compared to those who are learning Arabic. Dodd et al. (2003) found that this pattern resolves by the age of 4;0. For Arabic, Dyson and Amayreh (2000), Ammar and Morsi (2006) and Ayyad (2011) all agree that for Arabic-speaking children, the unstressed syllable deletion pattern resolves by the age of 4;5. The rationale for this error pattern is that stressed syllables are more perceptually salient and unstressed syllables are prone to deletion (Yavaş, 1998).

Both Arabic and English languages are classified as *stress-timed* languages (Abercrombie, 1967). However, Arabic and English were found to differ in the timing of stressed syllables within a phrase (Tajima, Zawaydeh, & Kitahara, 1999). In Arabic, the stressed syllables (within a phrase) were found to deviate from a strict isochrony frequency (i.e. the occurrence of regular stress beats) to a greater extent compared to English (more details in section 3.5.6 of Chapter 3). This in turn may have some influence on the perceptual saliency of a syllable, which plays a major role in the development of this particular error pattern. Further acoustic research is needed to clarify the difference between Arabic and English isochrony and its influence on the perceptual saliency of a given segment.

In addition to the similarities in the occurrence of error patterns in both Arabic and English languages, there were also a number of patterns that were exclusively observed in the speech of children learning one language but not the other. For instance, several patterns were only observed in the speech of children acquiring Arabic, such as de-emphasis, de-voicing, glottalization, metathesis and epenthesis error patterns; several other patterns were only observed in the speech of children acquiring English such as de-affrication and voicing error patterns. Differences between Arabic and English may influence the occurrence of a pattern in one language but not the other. For example, the de-emphasis error pattern can only be observed in Arabic because emphatic consonants do not occur in English.

Moreover, the phonetic detail of a sound that occurs in both languages, such as /r/, may also influence the type of error pattern which occurs. Error patterns affecting the voiced alveolar /r/ were observed in the speech of children learning Arabic and English. For Arabic, voiced alveolar /r/ is either trilled or tapped, and is often lateralized in erroneous production. In contrast, the voiced alveolar /r/ is produced as approximant /ɹ/ in English and often glided in erroneous production. Therefore, this error pattern was reported as being realised as liquid /r/→[w] in the studies of English-speaking children (Dodd et al., 2003; McIntosh & Dodd, 2008); the same sound was reported to be realised as /r/→[l] in the studies of Arabic-speaking children. One explanation could be that the /r/ realisation differs in Arabic and English languages. In Arabic, the /r/ is tapped or trilled, while in English it is realised as an alveolar approximant /ɹ/. The Arabic tap /ɾ/ or trill /r/ share the alveolar place of articulation with /l/, whereas the English approximant /ɹ/ involves retroflexion of the tongue against the back of the mouth with no alveolar contact. The /ɹ/ shares more features with /w/ compared to /l/, such as [-trilled], therefore, English speaking children are more likely to substitute /ɹ/ with /w/ rather than /l/ (Ayyad, 2011). The subtle difference between the realisation of /r/ in Arabic and English could influence the phonological saliency and/or the articulatory complexity of the /r/ sound which could be reflected in the speech of the developing child. Other factors, such as the frequency of occurrences and the functional load could possibly influence the development of error patterns in the child's speech (Stokes & Surendran, 2005). However, for the development of Arabic phonology, data regarding the frequency and functional load has yet to be sufficiently documented, and the influence of other factors is not yet clear.

The research literature covering monolingual phonology in English is substantial but is limited regarding other languages, including Arabic. To date, most of the available research focuses on monolingual Jordanian and Palestinian Arabic (Amayreh, 2003; Amayreh & Dyson, 1998; Dyson & Amayreh, 2000). Egyptian Arabic (Ammar & Morsi, 2006; Omar, 1973) and one study focuses on of Kuwaiti Arabic (Ayyad, 2011). In general, there are several factors that may limit researchers' interest in the development of the Arabic language, such as:

- the complexity of Arabic morpho-phonological structures;
- the existence of multiple dialects across the Arab world (Amayreh & Dyson, 1998);
- the prominence of the diglossic nature of spoken Arabic (Dyson & Amayreh, 2000);
- the general lack of research interest in language acquisition in the Arab world.

The development of different word shapes follows similar patterns in Arabic and English (Ayyad, 2011). Both the Arabic and English studies reported three common patterns affecting word shapes: syllable deletion, final consonant deletion and cluster reduction. Table 2.9 shows that patterns affecting word shapes appear to resolve earlier in Arabic compared to English. The developmental rate of these error patterns could possibly reflect the linguistic differences between Arabic and English. The Arabic morpho-phonological system is rather complex compared to English. The Arabic language is rich with bound morphemes that fall into three categories: templatic morphemes, affixational morphemes and non-templatic word stems. Affixational morphemes are concatenated to form words, while templatic morphemes are interleaved. Templatic morphemes come in three types that are equally required to create a word stem: roots, patterns and vocalisms which can precede, follow or surround the word stem, and can be classified into prefixes, suffixes and circumfixes, respectively. Finally the non-templatic word stems are word stems that are not constructed from a root/pattern/vocalism combination (Habash, Rambow, & Kiraz, 2005). Word shapes in Arabic are guided by the inflectional paradigm of templatic morphemes (Aronoff, 1993; Bat-El, 2003). For example, the verb /kataba/ *wrote* in Arabic (stem /ktb/) can take one of many shapes in Kuwaiti Arabic, such as:

/ki.tab/   *wrote* (verb) + masculine + past tense

/jak.tib/   *writing* (verb) + masculine + present tense

/kti.bat/   *wrote* (verb) + feminine + past tense

/tak.tib/   *writing* (verb) + feminine   + present tense

From this example, it can be seen that the prosodic shapes determine the phonological shape of the verb by altering its vowels:

e.g.   MSA   /ka.ta.ba/   →   KA   /ki.tab/   'he wrote'

Or its prosodic structure and its affixes;

e.g.   MSA   /ka.ta.ba/   →   KA   /tak.tib/   'she wrote'

CV.CV.CV   CVC.CVC

The interplay between phonology and morphology in speech acquisition is a rather complex process; the influence of morphological typology is often guided by the ease of phonological segmentation (Peters, 1995). The interleaved morphological structures of Arabic could possibly influence the rate of Arabic phonological development compared to English. However, the relationship between the development of Arabic morphology and phonology is a major area of research that has received inadequate attention by researchers.

The differences between Arabic dialects may also influence the nature of the reported results and the generalizability of the findings. For example, some Arabic dialects allow stopping of fricatives in certain environments. For example, some dialects of Kuwaiti Arabic allow de-voicing and stopping of /ɣ/ to be realised as [q]:

e.g.   /ˈɣa.latˤ/   →   [ˈqa. latˤ]   'wrong'

Although the realisation of this fricative as a stop would reduce the articulatory complexity of the /ɣ/ fricative, which is expected during the development of Kuwaiti Arabic phonology, this pattern also occurs in the adult's casual speech; thus is not counted as an error.

Similarly, Kuwaiti Arabic also allows spirantization patterns in some environments which have been counted as error pattern by some researchers (Ayyad, 2011). For example, in Kuwaiti Arabic, the voiceless /q/ is often realised as [ɣ] in certain phonological environments:

e.g. (1) /qi.ˈtˤaːr/ → [ɣi.ˈtˤaːr] *train*

(2) /ˈɣur.fa/ → [ˈqur.fa] *room*

The first example (1) was used by Ayyad (2011, p. 58) to illustrate the spirantization error pattern in Kuwaiti Arabic-speaking children aged between 3;10 and 4;3; however, this pattern often occurs in the adult's casual speech. In some Arabic dialects used in Kuwait the contrast between /q/ and /ɣ/ is lost. Both consonants are used interchangeably and maintain the same meaning, such as in examples (1) and (2) above. The fact that subtle differences between dialects of Kuwaiti Arabic[1] were hardly ever been documented in the literature (Taqi, 2009) makes it even harder to identify patterns that occur normally in Kuwaiti Arabic and other Arabic dialects. Similarly, some dialects spoken in Jordan and Egypt tend to realize /q/ as a glottal stop /ʔ/. Dyson & Amayreh (2000) reported this pattern as a fronting error and consequently justified the presence of this error pattern by referring to it as dialectal sound change that occurs normally in adult's speech which in turn results in a low input frequency of /q/.

Dialectal variations of the Arabic language could possibly influence the frequency (and functional load) of some Arabic consonants. In the case of /q/ and /ɣ/ in Kuwaiti-Arabic, if the /q/ and /ɣ/ are used interchangeably in word initial positions and maintain the word meaning; the functional load of those consonants is relatively low regardless of the frequency of its occurrence (which is unknown). Similar to English, /ð/ is the second most frequent fricative it has a relatively low functional load (Ingram, 1989). The high frequency of /ð/ is caused by its occurrence 'in a small class of frequent words and subsequently enters into a small number of minimal pairs' (p. 218). Ingram (1989) suggested that all /ð/s in English could be replaced with [d]s and still maintain their intended meaning. This could be the case for the allophonic /q/ and /ɣ/ in Kuwaiti Arabic, however, conclusions cannot be derived without sufficient information about frequency of occurrence and functional load in Arabic. These examples indicate that children acquiring different dialects of the same

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[1] Phonological differences between two main variants of KA (Najdi and Bedouin) have been described by Taqi (2009); however, the current literature lacks sufficient

language, such as Arabic, can show great variation within the same language.

Furthermore, Amayreh and Dyson's (1998) study showed that medial consonants were produced more accurately than initial and final consonants; however, there were no significant differences between the initial and final positions. The researchers conducted further analysis in order to determine if the medial position was a better position for production. The analysis revealed that accuracy was even greater for fricatives and sonorants words medially: children in eight out of nine groups produced the medial fricatives more accurately than the other positions; and medial sonorants had the highest accuracy in the production of all nine groups. The authors suggested that normally developing children should produce medial consonants correctly; an inability to do so would imply a delay in phonological development. Other influential factors such as frequency, salience of gemination and syllable structure were not taken into account for the level of accuracy observed in Amayreh and Dyson's (1998) study. This is because the current literature lacks essential information about frequency, gemination saliency and syllable structures of the Arabic language in general. All these factors need to be investigated thoroughly in order to establish normative data that represents the speech development of Arabic-speaking children. Further research on the development of Arabic word structure is needed.

Despite the differences in methodology used in each normative study reported as part of this research, there is some evidence of shared patterns between Arabic and English that occur in children's speech. Error patterns that occur in one language but not the other can also provide valid grounds to establish language-specific patterns. Possible reasons for the difficulties and constraints that result in error patterns can fall into four main categories: articulation complexity, phonological saliency of consonants or sound combinations, frequency of occurrence, or functional load of consonants. These factors will be explored in Chapter 6 alongside the findings of the current study.

2.4. Comparison of findings reported in Arabic and English studies

Cross-linguistic studies compare the rate and route of emergence of Arabic error patterns with that of English (Amayreh & Dyson, 2000; Ayyad, 2011). Against the theoretical background discussed above, this section will present a comparison of the order of acquisition in Arabic and English in an attempt to highlight the development of language-specific error patterns and the influence of markedness, phonological saliency, frequency and functional load during the developmental course.

Table 2.10 presents a comparison of the order of acquisition of Arabic and English consonants. Consonants that have been reported as 'mastered' or 'acquired' consistently (i.e., within an age group) by at least two studies are listed. The ages of acquisition are divided in three developmental periods: early, intermediate and late. These periods are based on the data presented in all Arabic and English studies summarised above in relation to age groups.

Language	English	Arabic
Early sounds (<2;0-3;0)	Stops /p, b, t, d, k, g/ Nasals /m, n/ Fricative /f *, h/ Glide / j /	Stops /b, t , d, q*, ʔ/ Nasals /m, n/ Fricatives /f*, ʃ*, ħ, ʕ*, h*/ Glides /j, l, w/
Intermediate sounds (3;1-4;0):	Fricatives /f, s, z, ʃ/ Affricate /ʧ/ Glides /l, w/	Stops /tʕ, dʕ, q, k/ Fricatives /f, θ, ðʕ*, s, sʕ, z, ʃ , x, ɣ, ʕ, h/ Affricates /ʤ */ Glides/r/
Late sounds (>4;0):	Fricatives /θ, ð/ Affricate /ʤ/ Glide /r/	Fricatives /ð, ðʕ/ Affricate /ʤ, ʧ */

* Reported by one study only

Table 2.10: Comparison of the order of acquisition of Arabic and English consonants

Table 2.10 shows an overview of the order of acquisition in Arabic and English. It is important to highlight the difference in the inventories of both languages before comparing the order of acquisition. A unique feature of Arabic is the inclusion of 'emphatic' consonant phonemes, which are produced with a secondary articulation in which the root of the tongue is retracted toward the

back wall of the pharynx. The following five consonants: /dˤ/, /tˤ/, /sˤ/, and /ðˤ/ have this characteristic. The /q/ has no non-emphatic cognate in Arabic. In addition, /ħ/, /r/, /x/ and /ɣ/ are emphatic in certain environments (Shahin, 1996). Standard Arabic consonants lack the English /p/ and /g/ sounds.

A general trend in the order of acquisition is noticeable in both languages. As seen in table 2.10, children learning Arabic or English tend to acquire stops /b, t, d/, nasals /m, n/, glide /j/, followed by fricatives /s, z, ʃ/, then /ð/ and affricate /dʒ/ in a similar order. In terms of markedness, the early-acquired stops are unmarked (less complex) sounds such as stops and nasals, in contrast to the late acquisition of more marked (more complex) sounds such as fricatives and affricates. There is also an apparent influence of the articulatory complexity and perceptual saliency on the order of acquisition in both Arabic and English data.

According to the notion of markedness, the unmarked member of an opposition is widely considered to be easier and less complex than the marked counterpart in terms of production. For example, the stops /t, d/ are predicted to be acquired before their emphatic counterparts /tˤ, dˤ/ in Arabic. This is also apparent in the acquisition of English consonants, where stops and nasals are relatively easy to articulate compared to fricatives and affricates; this is reflected in the order of acquisition, where stops are acquired before fricatives and affricates.

The influence of perceptual salience is believed to influence the order of sound acquisition. Sounds that are more salient are expected to occur earlier in the child's speech. From the available data, this was true for both languages. English-speaking children acquire the /j/ before /s, z, ʃ/. A similar pattern is also evident among Arabic-speaking children. Arabic- and English-speaking children acquire consonants of their language at different rates. Table 2.10 shows that the glides /l, w, r/ and fricatives /θ, f/, are acquired earlier by Arabic- compared to English-speaking children. The early acquisition of these sounds in Arabic may imply the influence of one or more factors. For instance, Amayreh and Dyson (1998) claimed that the earlier emergence of /l/ reflects the high frequency of occurrence of these segments in the ambient language. They compared the frequency of occurrence of consonants in child and adult speech

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and found that /l/ is frequently targeted, and was acquired earlier in Arabic-speaking than English-speaking children, although no statistical analysis was reported.

Amayreh & Dyson (1998) argue that the back fricative /x/ is acquired relatively early in Arabic because of its high functional load and phonological saliency. The measurement of functional load was based on qualitative parameters (frequency of occurrence and number of contrasts in the language). Amayreh and Dyson (1998) claim that the uvular fricatives are produced with a large amount of low frequency energy in contrast to alveolar or palatal fricatives (Ladefoged & Maddieson, 1996); therefore, they are more salient and are predicted to be acquired earlier than other fricatives. However, Table 2.10 illustrates that Arabic-speaking children acquire labial /f/ and dental /θ/ fricatives at the same time as the back fricative /x/. If it is true that /x/ is acquired early because it is more salient than other fricatives, then it should be acquired earlier than other front fricatives (further discussion can be found in section 6.1.6 of Chapter 6). The back fricative /x/ is unique to the Arabic language in this context, as it does not occur in English. The dental fricative /θ/, on the other hand, occurs in both Arabic and English; it is acquired earlier by Arabic-compared to English-speaking children. Because this sound is highly marked in both languages (based on articulatory complexity and perceptual saliency), the influence of functional load and/or input frequency could be the reason for the earlier acquisition in Arabic compared to English. None of the studies under review provided sufficient information on functional load and how it is calculated.

Undertaking a comparison of the development of consonant clusters is rather challenging. Based on the available data, the development of consonant clusters reported by one Arabic study and one English study (Ayyad, 2011; Stoel-Gammon, 1987). The data provided by both studies is not comparable. Stoel-Gammon (1987) reported findings of spontaneous speech samples gathered from English-speaking children aged 2;0, whereas Ayyad's (2011) findings were based on speech elicited from Arabic-speaking children (picture-naming task) aged between 3;10 and 5;2. The latter method of speech

elicitation can limit the child's production and may not reflect the natural occurrence of consonant clusters in the child's casual speech.

2.5. Methodological issues: general comments

2.5.1. Study design

Studies of phonological acquisition usually adopt a cross-sectional design in which children are selected across a number of age bands. This would only provide probabilistic statements regarding the rate and pattern of development and minimize individual differences where the sequential developmental pattern of an individual child is not traced. Individual variations in early phonological development are well documented in the current literature (e.g. Fikkert, 1994; C. Levelt, 1994; Stemberger & Stoel-Gammon, 1991), therefore, they should be taken into account when establishing and applying norms (Dodd et al., 2003).

Another issue of concern is that some sounds might be produced correctly by more children in a younger age group than those in an older age group. Since the cross-sectional study cannot trace sequential development of phonemes, and different groups of children were examined in different age ranges, some of this might result in statistical artefact. For example, if a younger group of children produced a given sound correctly more often than the older group, the sound would be reported as being produced in the early stage of development rather than in the latter stage. This result may be regarded as developmental regression.

The nonlinear process of phonological acquisition described by Smith (1973) involves some sort of regression. It was reported that during the course of development, the child fails to produce sounds, which he or she has been able to produce correctly on previous occasions (Smith, 1973). This phenomenon not only occurs at an individual level, but may also be evident at a group level. Therefore, acquisition criteria need to be established to maintain consistency across different sounds (Dodd et al., 2003). Hence, the sound needs to be produced with 90% accuracy by at least two consecutive age groups to satisfy these criteria.

2.5.2. Variability

Variability in young children's speech production has often been extensively reported, particularly during the early stages of speech development (Holm, Crosbie, & Dodd, 2007; Hua, 2006; Ingram, 1989a; Stackhouse & Wells, 1997; Vihman, 1996). Therefore, taking into consideration both individual variation and group trends in phonological acquisition is essential. A distinction can be made between 'customary production', where the sound is produced correctly in at least two of three word positions, and 'mastery production' where the sound is produced correctly in all word positions. Hua (2006) also made a distinction between 'phoneme emergence' (i.e., producing a sound correctly at least once) and 'phoneme stabilization' (i.e., producing a sound correctly at least two out of three opportunities). Amayreh and Dyson (2000) have also considered individual variability as well as group trends by incorporating both 'phoneme emergence' and 'phoneme stabilization' in their criteria. They defined three types of age of acquisition: 'age of customary production' (i.e., at least 50% of children in an age group produce the sound correctly in at least two positions); 'age of acquisition' (i.e., at least 75% of children in an age group produce the sound correctly in all positions); and 'age of mastery' (i.e., at least 90% of children in an age group produce the sound correctly in all positions). At the 'age of mastery', they allowed 10% of variability in the children's word production. This was later supported by Holm et al's (2007) cross-sectional study of 409 typically developing English-speaking children aged between 3;0 and 6;11. The aim of their study was to differentiate normal 'variability' from 'inconsistency' in children's speech. They provided detailed definitions for both the terms 'variability' and 'inconsistency'. The former was defined as 'repeated productions that differ, with the variability attributed to factors described in normal acquisition and use of speech' (Holm et al., 2007, p. 467), such as phonetic context, pragmatic influences, maturation or cognitive-linguistic influences. The latter was 'characterized by a high proportion of differing repeated productions with multiple error types [with] unpredictable variation between a relatively large number of phones and/or structural changes that cannot be attributed to factors responsible for normal variability' (Holm et al., 2007, p. 468). The results of this study provided evidence that children's word

productions elicited in the same linguistic context are highly consistent. There was also evidence of limited variability in the youngest age group, which was markedly decreased with age.

2.5.3. Data elicitation process

Studies of child speech development often involve one of two main methods of data elicitation to obtain a representative speech samples: picture-naming task or spontaneous conversation samples. On one hand, many cross-sectional design studies used well-designed picture-naming and picture description tasks in order to increase consistency across the data, making it feasible to undertake comparisons and make generalisations (Dodd et al., 2003). Several considerations have been taken into account in the design of these tasks: first, they provide opportunities of all the phonological features or phonemes; second they include opportunities of all the phonemes in each 'legal' word or syllable position; third, the choice of words are within the child's lexicon; fourth, they include a balanced but not equal frequency of occurrence of phonemes. On the other hand, several early data on phonological acquisition were based on observational diaries of speech samples collected in unstructured naturalistic settings, usually in mother-child interaction (Dodd et al., 2003; Vihman, 1996, 2014).

Formal ways of eliciting the data (i.e. picture-naming) may sometimes lead the child to mispronounce or skip a phoneme for other reasons, such as a lack of familiarity with the test item. Therefore, spontaneous speech elicitation method is favoured especially with a young participant population, not to limit their linguistic abilities to a set number of words or word structures. For instance, if the child does not name a 'butterfly' picture it does not mean that this child is unable to produce the word structure of this specific word 'butterfly', given the possibility that the child's vocabulary is relatively limited at this specific age. Picture naming tasks are believed to reduce the effect of phonological selectivity inherent in naturalistic observation. In other words, the absence of a given sound in an unstructured approach of data collection can be either due to

the child's inability to produce the sound in question or due to the lack of opportunity or limited vocabulary.

Spontaneous speech production in a naturalistic environment is essential in normative developmental studies. However, naturalistic spontaneous speech sampling may not contain all possible phonemes especially among the younger age group. However, with the large number of recruited subjects, the possibility of missing phonemes may be minimized. Also, a common problem encountered during the spontaneous speech sampling process is that adults are notorious for talking over the process; they ask the children questions and answer them before the children have had a chance to respond, or they ask to the children to imitate when they are trying to name an item but can't remember what it is. In many cases the child may experience temporary lexical retrieval problems (e.g. Amayreh & Dyson, 1998; Dodd et al., 2003) so is unable to fulfil the phonological task without assistance (e.g. imitation or presentation of forced choice). To develop norms from naturally occurring speech, the parent-child interaction style should not be interrupted.

2.6. Conclusion

While the previously discussed studies have undoubtedly furthered our understanding regarding the role of ambient language effects on phonological learning, a major problem continuing to plague research in this area is a lack of consensus about what constitutes markedness, phonological saliency, occurrence frequency and functional load. This remains a major area of debate. For instance, the concept of functional load as introduced by Ingram (1989) and Pye et al. (1987) was originally used to explain the early acquisition of complex or less 'preferred' consonants by children from some language groups. That is, if a consonant is learned earlier than expected, it is possible that the consonant occurs frequently in a given language and functions in many phonological oppositions, and therefore, has a high input level for children learning to speak; it seems reasonable that the reverse could also be true. The influence of

frequency and sonority will be discussed in detail in Chapter 6 of this thesis, which will include the findings of the current study.

Chapter 3:

Introduction to Arabic and Kuwaiti Arabic

3. Chapter Three: Introduction to Arabic and Kuwaiti Arabic

Arabic is a Central Semitic language, thus related to and classified alongside other Semitic languages such as Hebrew and the Neo-Aramaic languages. In terms of speakers, the Arabic macro-language is the largest member of the Semitic language family. Arabic has many different, geographically distributed spoken varieties, some of which are mutually unintelligible (Holes, 2007).

Arabic is the main language in the Arab countries that occupy most of the Middle East and North Africa. Approximately 200 million people in that region speak one variety of Arabic or another as their first language (Gordon & Grimes, 2005). Additionally, more than 1 billion Muslims around the world use Classical Arabic (CA) as a liturgical language. Followers of Islam believe that Islam's Holy book is the Qur'an. The book is worded in a form of CA and is believed to be the direct words of Allah (God). CA is usually referred to as /fusˤħaa/ meaning '*the clearest*' in English.

Arabic has lent many words to other languages of the Islamic world. During the Middle Ages, Arabic was a major vehicle of culture in Europe, especially in science, mathematics and philosophy (see 3.3 for examples). As a result, many European languages have also borrowed many words from it. Arabic influence is seen in Mediterranean languages, particularly Spanish, Portuguese, and Sicilian, due to both the proximity of European and Arab civilization and 700 years of Arab rule in the Iberian peninsula (Holes, 2007).

3.1.   Classical, Modern Standard, and colloquial Arabic

Arabic usually consists of one of three main varieties: Classical Arabic; Modern Standard Arabic; colloquial or dialectal Arabic.

3.2.1. Classical Arabic (CA)

Classical Arabic is the language found in the Qur'an and used from the period of Pre-Islamic Arabia prior to 630 CE to that of the Abbasid Caliphate in 750 CE. Classical Arabic is considered normative; modern authors attempt to follow

the syntactic and grammatical norms laid down by classical grammarians (such as Sibawayh), and use the vocabulary defined in classical dictionaries (such as the Lisān al-Arab). Classical Arabic has also been a literary language and the liturgical language of Islam since its inception in the seventh century.

3.2.2. Modern Standard Arabic (MSA)

Over time, Arabic-speaking people developed, naturally, numerous regional vernaculars that are mostly spoken, but rarely written. MSA emerged as a direct descendent of CA to fill the need for a standardized form of Arabic that can also be expressed in writing. MSA emerged as a direct descendent of CA to fill the need for a standardized form of Arabic that can also be expressed in writing. Modern Standard Arabic derives from Classical Arabic, the only surviving member of the Old North Arabian dialect group, attested in Pre-Islamic Arabic inscriptions dating back to the fourth century (Holes, 2007). MSA consonants and vowels are illustrated in table 3.1 and figure 3.1 below. The MSA consists of 28 consonant and three vowel phonemes. These phonemes are essentially directly inherited from CA.

	Bila-bial	Labio-dental	Dental	Alveo-lar	Palato Alveolar	Pala-tal	Velar	Uvular	Phary-ngeal	Glot-tal
Stop	b			t d tˤ dˤ			k	q		ʔ
Fricative		f	θ ð ðˤ	s z sˤ	ʃ		x ɣ			h
Affricate				ʧ ʤ						
Nasal	m			n						
Trill				r						
Approximant	w						j w		ħ ʕ	
Lateral				l						

Table 3.1: Classical and Modern Standard Arabic consonant phonemes
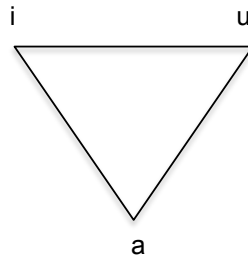
Figure 3.1: Arabic vowel phonemes.

Arabic, like other Semitic languages, is known for its root-and-pattern morphological system, which differs from other concatenative systems. The morphemes are interwoven rather than linearly ordered. Most Arabic stems are based on roots of two or three consonants between which vowels are inserted (Brustad, 2000). In general, the consonantal root carries the semantic meaning of the word while the vocalism and the vowel-consonant ordering reflect the word's inflection and its part of speech. For example, the words in (1) below are based on the tri-consonantal root "ktb" 'write'. Inflectional prefixes and suffixes can also be attached to the stems. Compare the examples in (2).

(1)   a.   katab   'wrote'
         b.   kutib   'was wrote'
         c.   ka:tib   'writer'
         d.   kita:b   'book'

(2)   a.   katab-a   'wrote' + 3rd person masculine singular
                katab-at   'wrote' + 3rd person feminine singular
          b.   ja-ktub   'write' + 3rd person masculine singular
                na-ktub   'write' + 1st person masculine/feminine plural

Following the theoretical proposal of McCarthy (1990), this morphological system poses to traditional linear theories by proposing the separation of the

consonantal root, the vocalism, and the CV skeleton of the word into separate autosegmental tiers. The consonants and vowels are mapped into the CV slots of the skeleton by means of association lines as shown in (3). As such, the consonants that appear separated by vowels in the surface structure of the word are adjacent at a different level.

(3)

Consonantal Tier	k	t	b
CV–Template	C V C V C
Vocalic Melody	a
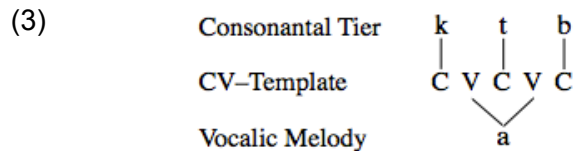
Like other languages, MSA continues to evolve. Many modern terms have entered into common usage; in some cases taken from other languages (for example, 'film') or coined from existing lexical resources (for example, /hātif/ 'telephone'). Structural influence from foreign languages or from the colloquial varieties has also affected MSA. For example, MSA texts sometimes use the format "A, B, C, and D" when listing things, whereas Classical Arabic prefers "A and B and C and D" (Holes, 2007; Al-Qenaie, 2011) and subject-initial sentences may be more common in MSA than in Classical Arabic. MSA is generally treated separately in non-Arab sources.

3.2.3. Colloquial Arabic

Over time, Arabic-speaking people naturally developed numerous regional vernaculars that are mostly spoken, but rarely written. Colloquial or dialectal Arabic refers to the many national or regional varieties, which constitute the everyday spoken language. Colloquial Arabic has many different regional variants; these sometimes differ enough to be mutually unintelligible and some linguists consider them distinct languages (Holes, 2007). The varieties are typically unwritten. They are often used in informal spoken media, such as soap operas and talk shows (Holes, 2007) as well as occasionally in certain forms of written media, such as poetry and printed advertising. The only variety of modern Arabic (through its descent from Siculo-Arabic) to have acquired official language status is Maltese, spoken in Malta and written with the Latin alphabet.

3.2. Diglossia

The sociolinguistic situation of Arabic in modern times provides a prime example of the linguistic phenomenon of diglossia, which is the normal use of two separate varieties of the same language, usually in different social situations. In the case of Arabic, educated Arabs of any nationality can be assumed to speak both their local dialect and their school-taught MSA (Holes, 2007). When educated Arabs of different dialects engage in conversation (for example, a Moroccan speaking with a Lebanese), many speakers code-switch back and forth between the two varieties of the language, sometimes even within the same sentence. Arabic speakers often improve their familiarity with other dialects via music or film. Quite often, in countries such as Egypt, a case of "triglossia" can be argued to take place, in which a speaker could switch back and forth between the dialect of his or her hometown, the standardized (in practice "metropolitan") national dialect and finally, supranational MSA.

At present MSA is the language of the media, the public education systems, practically all written and technical forms of Arabic, as well as intellectual circles and political speeches. According to Holes (2007), the broad reach of education and mass media exposure has a levelling influence which brings the divergent Arabic dialects gradually closer to MSA. Hence MSA is thought to be a pan-Arab lingua franca used whenever dialectal differences veer into unintelligibility.

The current MSA is a descendant of CA and retains the basic syntactic, morphological, and phonological systems. Bateson (1967) lists the following main differences between MSA and CA: First, MSA resembles a simplified form of CA. This simplification is mostly realised as limitations placed on the choices of syntactic structures and vocabulary used. MSA only uses a subset of the possible syntactic structures available in CA as well as a considerably reduced lexicon. Second, the newly derived lexicon is included in MSA, in addition to coined, and borrowed vocabulary items that are intended to address the need for technical and other modern-use terminology; and third, due to the influence of European languages, idiomatic, stylistic, and even syntactic innovations are introduced to the MSA. Such influences are brought about mostly by direct

translations of European texts into Arabic.

As stated above, MSA is often used in educational contexts, however, the age of the audience, the nationality of the teacher, and the subject matter govern the communication medium. Children in early governmental educational settings, such as kindergarten, are usually taught in an educated form of the local dialect. However, employees of most private childcare are foreign expatriates (often originating from other Arab countries such as Egypt and Jordan and less commonly from non-Arab countries). Informal written Arabic containing dialectal forms is common in cellular phone text messaging, notes and other ephemera such as newspaper cartoons (Holes, 2007).

3.3.   Arabic and other languages

Some words in English and other European languages are derived from Arabic, often through other European languages, especially Spanish and Italian. Among them are commonly used words like /su.k:ar/ 'sugar' and /qutˤn/ 'cotton'. English words more recognizably of Arabic origin include 'algebra' and 'alcohol'. Borrowing from English (and other languages) has been historically documented (Holes, 2007) and is still increasing in the modern world. The change has been influenced by many factors, such as immigration and population movement, the early introduction of formal English language teaching in formal educational systems across the Arab world, and the use of modern technology in various contexts including youth entertainment (e.g. internet and computer games).

In the Arabian Gulf area, for example, the presence of many immigrants from the Indian subcontinent who work in an Arabic-speaking environment with minimal knowledge of Arabic language has resulted in the formation of a uniform Arabic pidgin in the Arabian Gulf area (Holes, 2007). Historically, this pidgin has been typically used in market transactions and work places. However, with the current lifestyle change and its needs, it is not uncommon for families to hire a full-time foreign expatriate as a nanny or a housemaid who lives in the family house and provides care for their children. Although some

may have minimal knowledge of English, Arabic pidgin can still be used by an Arabic-speaking person giving instructions to their non-Arabic-speaking nanny.

3.4.   About Kuwait

Area:

The State of Kuwait is a sovereign Arab Emirate situated in the northeast of the Arabian Peninsula in Westerns Asia. The name *Kuwait* is derived from the Arabic "akwat", the plural of "kout", meaning fortress built near water (Holes, 2007). Kuwait covers an area of 17,818 square kilometres (6,880 square miles) of perfectly flat expense of desert with borders to the north and northwest with Iraq and to the west and south with Saudi Arabia.

Population demographics:

As of July 2009, Kuwait has a population of about 2.7 million including 1.3 million non-nationals (Kuwait Government Online, 2013). Kuwaiti citizens are considered to be minority of those who reside in Kuwait. The government does not grant citizenship to foreigners to maintain status. The composition of its population in 2009 estimate is summarized in the table below.

Age group	Percentage	Male/female ratio
0-14 years	26.4%	361,274/348,351
15-64 years	70.7%	1,219,674/683,494
65 years and over	3%	49,807/29,926

Table 3.2: Breakdown of population of The State of Kuwait

In 2008, 68.4% of the population consisted of expatriates. The net migration rate of the country stood at 16.01, the third highest in the world. In 2009, more than 580,000 Indian nationals lived in Kuwait, making them the single largest expatriate community there. In 2003, there were also an estimated 260,000 Egyptians, 100,000 Syrians and 80,000 Iranians in Kuwait (Kuwait Government Online, 2013).

Languages spoken in Kuwait:

Kuwait's official language is Arabic, though English is widely spoken. Other important languages include Persian, Hindi, Malayalam, Telugu, Tamil, Urdu, Bengali, and Tagalog. People in Kuwait speak a dialect of Gulf Arabic, and Modern Standard Arabic is taught in schools. English is the second language taught in public schools.

Socio-economic structure:

Kuwait has a geographically small, but wealthy, relatively open economy with self-reported crude oil reserves of about 102 billion barrels - about 9% of world reserves. Petroleum accounts for nearly half of Gross Domestic Product (GDP), 95% of export revenues, and 95% of government income (Kuwait Government Online, 2013).

Ethnic backgrounds:

The population consist of 45% Kuwaiti, 35% other Arab, 9% South Asian, 4% Iranian and 7% other nationalities (Kuwait Government Online, 2013).

Religions:

Almost all of the population of Kuwait are Muslims (85 %), half being Sunni Muslims and a third Shi'ite Muslim (70% and 30% respectively). There are small Christian, Hindu and Parsi communities, as well as other Muslim groups (15%). Roman Catholic, Church of England, Armenian, Greek, Coptic and Syrian Orthodox churches cater for the expatriate communities (Kuwait Government Online, 2013).

The origins of Kuwaiti Arabic:

This section discusses the formation of the Kuwaiti dialect and some of its phonological features to enable the reader to attain a perspective of the language of the society under study.

There are two major varieties of Kuwaiti Arabic, namely, Modern and Bedouin. Modern Kuwaiti Arabic is a dialect that developed as an outcome of social

contact and economic change. The Kuwaiti Royal family and the Najdi families who migrated with them during the 18th century mainly spoke a Modern Kuwaiti Arabic dialect, which is distinctive from the Bedouin dialect (Taqi, 2009). Because of the different backgrounds of the Kuwaiti people and their connections with people from the outside world, some changes started to evolve. Holes (2007) found that, in addition to phonological features, many lexical items were borrowed from Mesopotamia due to Babylonian commercial and political influence in the region for a long period of time such as in the words [tˤuˈbaʕ] 'sink' and [ziˈbiːl] 'basket'. Holes (2007) also noted that in Kuwait, the distinction between Kuwaitis and non-Kuwaitis is socially evident. This distinction is between Kuwaitis who are full citizens and who are mostly merchants and descendants from the Najdi tribes who migrated alongside the Royal family (Al-Sabah), and other Bedouin tribes who came from Saudi Arabia and Iraq late in the 1950s.

During the 1940s, shortly after the discovery of oil, many people migrated to Kuwait, and Kuwaitis started traveling abroad for education and trade purposes. This resulted in constant contact with speakers of other Arabic dialects as well as other languages. Such contact has influenced KA, and induced borrowing of lexemes from other Arabic varieties like Farsi, Indian and English. Many lexical items have changed as a result of direct social contact between educated people in Kuwait and foreign merchants. In contrast, the Bedouin dialect was preserved to some extent as a result of a conservative lifestyle, which made the Kuwaiti Bedouins less likely to communicate with people from outside of Kuwait (Taqi, 2009, p. 67). Holes (2007) reported that the Kuwaiti dialect is the most similar to the Bahraini dialect (p. 609). This is shown especially when comparing the Najdi dialect with Bahraini Arabic (Taqi, 2009). For example, both Kuwaiti Najdis and Arab Bahrainis use [q] for /ɣ/ and [ɣ] for /q/; as in /ɣurfa/ 'room' realised as [qurfa], and /qalam/ 'pen' realised as [ɣalam]. In addition, /dʒ/ is realised as [j] in both dialects, e.g. [jild] 'leather'. Additional common features between the two dialects include the use of [tʃ] instead of /k/ as in the word [ˈbaː.tʃir] 'tomorrow'. Moreover, /q/ is often realised as [dʒ] such as in the realisation of /ˈbaː.qi/ as [ˈbaː.dʒi] 'remainder' (Taqi, 2009).

KA is spoken by Kuwaitis, and may differ slightly according to the speaker's ethnicity (Ajami, Najdi or Bedouin). Thus the speech varieties in Kuwait are socially classified. Other non-Kuwaiti dialects commonly used in Kuwait are the Egyptian, Palestinian, Jordanian and Syrian, that in addition to other Non-Arab languages such as English, Farsi, Hindi, Urdu and Tagalog.

In a diglossic scenario, KA and MSA exist side by side in the Kuwaiti language community, as in most cases, KA is often the first language learned by Kuwaiti children learned during the pre-school period. KA is the informal language used in social situations such as when talking with friends or co-workers. MSA is often used in formal situations such as speeches, news reports and televised programs.

3.5.   The phonology of Kuwaiti Arabic

This section will introduce some characteristics of standard spoken Arabic focusing on Kuwaiti Arabic. Sibawayh, the eighth-century CE Arab grammarian, was the first to describe the consonantal system of CA. CA has twenty-eight consonantal phonemes in nine places of articulation. There has been a change in the frequency and realisations of these consonantal phonemes in almost all dialectal variations of MSA. However, nomadic dialects and dialects of the Arabian Gulf tend to retain most features of CA and MSA sounds. Most of the lexical items of Kuwaiti Arabic resemble those of MSA, with some borrowings from English, Farsi and Indian languages (Holes, 2007).

Kuwaiti Arabic is a dialectal variant of MSA. It shares many distinctive segments with other dialectal varieties spoken in the Gulf areas such as Bahrain, Oman and Eastern Saudi Arabia. The consonantal segments of KA are illustrated in table 3.3.

	Bilabial	Labio-dental	Dental	Alveolar	Palato-Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
Stop	p b			t d tˤ dˤ			k g	q		ʔ
Fricative		f v	θ ð ðˤ	s z sˤ zˤ	ʃ		x ɣ			h
Affricate					tʃ	dʒ				
Nasal	m			n						
Trill				r						
Approximant	w						j w		ħ ʕ	
Lateral				l ɫ						

* Non-standard consonants that result from assimilation process, used on load words, or dialectal variants.

Table 3.3: Phonemic inventory of KA consonants.

In comparison with MSA, KA has a larger segment inventory, consisting of 32 phonemic consonants instead of 28. The following section lists KA consonants with brief summary of their special allophonic features in relation to KA.

3.5.1. Consonants

Stops:

Voiceless		Voiced	
/t/	apico-dental	/b/	labio-labial
/tˤ/	apico-dental velarized	/d/	apico-dental
/k/	dorso-velar	/dˤ/	apico-dental velarized
/q/	dorso-uvular	/g/	dorso-velar
/ʔ/	glottal		

Affrication on /k/ occur in the realisation of the second person, singular, feminine pronominal suffix -tʃ as in example (1); and in other environments such as in the following examples (2) to (4) (Al-Qenaie, 2011):

	MSA	KA	
	MSA	KA	
(1)	/mad.ra.sa.tu.ki/	/mad.ris.titʃ/	'your school'+ fem. 2nd person
(2)	/kalb/	/tʃalb/	'dog'
(3)	/sa.k:i:n/	/sa.tʃ:i:n/	'knife'
(4)	/ħink/	/ħintʃ/	'chin'

The /k/ affrication also occur in all words positions in contiguity of front vowels according to the following rule:

/k/ → [ʧ] / (V)   (C) ------------------ (C)   (V)

$$\left\{\begin{array}{l}(\text{+front}) \\ (\text{+back}) \\ (\text{+low}) \\ (\text{+long})\end{array}\right\} \left\{\begin{array}{l}\text{non-} \\ \text{emphatic}\end{array}\right\} \quad \left\{\begin{array}{l}\text{non-} \\ \text{emphatic}\end{array}\right\} \left\{\begin{array}{l}(\text{+front}) \\ (\text{+high}) \\ (\text{+low}) \\ (\text{+long})\end{array}\right\}$$
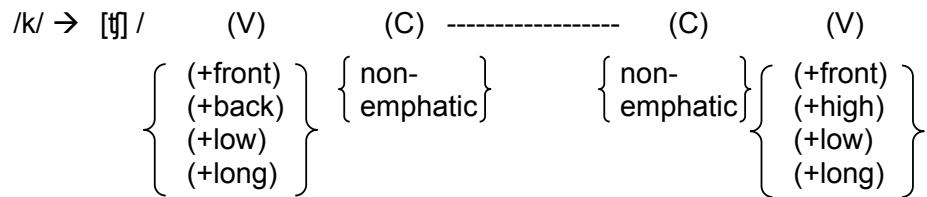
The voiceless uvular stop /q/ is realised as a voiced velar stop [g] (Al-Qenaie, 2011). The second variation, /q/ is often realised as a voiced post-alveolar affricate /ʤ/; the latter realisation is favoured mostly by 'ħa.ðˤar' speakers of KA (Urban KA), while the former is attested in both Bedouin and Urban KA speakers (Al-Qenaie, 2011; Taqi, 2009). For example:

	MSA	KA	
(8)	/qutˤn/	/gi.tˤin/	'cotton'
(9)	/qaːl/	/gaːl/	'he-said'
(10)	/ba.qa.ra/	/bga.ra/	'cow'
(11)	/qib.la/	/ʤib.la/	'direction'
(12)	/tˤa.riːq/	/tˤi.riːʤ/	'way' – 'road'

Both allophonic variations can occur in all word positions, and in immediate vicinity of front, long vowels, or when non-emphatic consonant intervene to the left according to the following rules (Al-Qenaie, 2011):

/q/ → [g] / (V)   (C) ------------------- (V)

$$\left\{\begin{array}{l}(\text{+front}) \\ (\text{+back}) \\ (\text{+high}) \\ (\text{+low}) \\ (\text{+long})\end{array}\right\} \left\{\begin{array}{l}\text{non-} \\ \text{emphatic}\end{array}\right\} \qquad \left\{\begin{array}{l}(\text{+front}) \\ (\text{+back}) \\ (\text{+high}) \\ (\text{+low}) \\ (\text{+long})\end{array}\right\}$$

$$/q/ \rightarrow [ʤ] / \quad (V) \qquad (C) \qquad \text{--------------------} \qquad (V)$$

$$\left\{\begin{array}{l}(+front)\\(+high)\\(+low)\\(+long)\end{array}\right\} \left\{\begin{array}{l}\text{non-}\\\text{emphatic}\end{array}\right\} \qquad\qquad \left\{\begin{array}{l}(+front)\\(+high)\\(+low)\\(+long)\end{array}\right\}$$
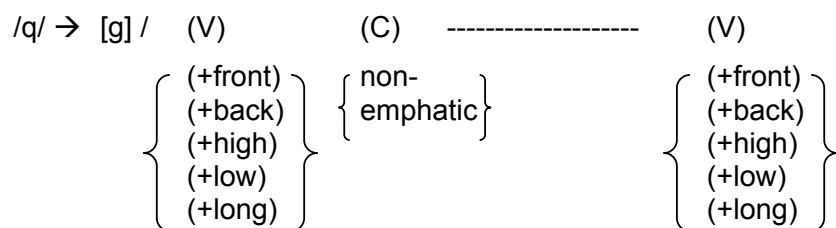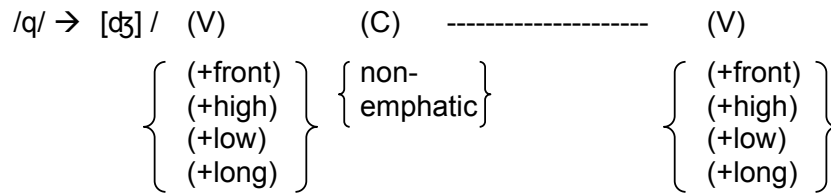
Affricates:

Voiceless		Voiced	
/ʧ/	lamino-alveolar	/ʤ/	lamino-alveolar

The realisation of /ʤ/ as [j] often occurs in KA adult speech. This allophony is considered a typical variant of KA and some dialects of Bahraini Arabic (Al-Qenaie, 2011; p.174); it is realised as a voiced palatal approximant. For example:

	MSA	KA	
(1)	/ʤa:r/	/ja:r/	'neighbour'
(2)	/ʤa:.ʔat/	/ʤat/-/jat/-/ja:t/	'she-came'
(3)	/da.ʤa:ʤ/	/di.ʤa:ʤ/-/di.ja:j/	'chicken'

This change seems to be lexically derived to some extent; many words have not been affected by this change, e.g. /ʤa.ri:da/ 'newspaper', /ʤam.ʕi.j:a/ 'supermarket', and /ʤa:m.ʕa/ 'university'. As seen in examples (2) and (3), palatisation does not occur systematically. In both words (and many other words), KA speakers of Bedouin origins maintain the /ʤ/, while 'ħa.ðˤar' speakers (Urban KA) are more likely to realize the /ʤ/ as /j/.

Fricatives:

Voiceless		Voiced	
/f/	labio-dental	/ð/	apico-interdental
/θ/	apico-interdental	/ðˤ/	apico-interdenta velarized
/s/	apico-dental	/z/	apico-dental
/sˤ/	apico-dental velarized	/ɣ/	dorso-velar
/ʃ/	lamino-alveolar	/ʕ/	radico-pharyngeal
/x/	dorso-velar		
/ħ/	radico-pharyngeal		
/h/	glottal		

Older KA speakers consistently realize /θ/ as [f]. /sˤ/ and /ðˤ/ often have a secondary velarization effect on surrounding consonants (e.g., MSA /dˤif.daʕ/ 'frog' is realised as [ðˤif.ðˤəʔ] in KA) and a backing and rounding effect on vowels, as was noted for /tˤ/ and /dˤ/ (e.g., /ða:b/ 'melted' is realised [ða:b] whereas /ðˤab/ 'lizard' is realised [ðˤɒb]). The voiced alveolar emphatic /dˤ/ is always realised as [ðˤ] in KA (Al-Qenaie, 2011); for example:

		MSA	KA	
(1)		/dˤɑb/	/ðˤɑb/	'lizard'
(2)		/jadˤ.ħak/	/jiðˤ.ħak/	'he laughs'
(3)		/baidˤ/	/bɛ:ðˤ/	'eggs'

As seen in examples (1) through (3), this was described by Al-Qenaie (2011) as a merger that occurs in all word positions:

/dˤ/ ⟶ /ðˤ/ -----------------------

Similarly, the [g] and the dorso-velar /ɣ/ are used interchangeably in all word positions Some KA speakers would distinguish /q/ from /ɣ/ (e.g. [bur.tu.ʼqa:l]-[bur.ʼtu.ɣa:l] 'orange' and [ˈqur.fa]-[ˈɣur.fa] 'room'). According to Taqi (2009), /ɣ/ is salient in KA and is affected by ethnicity, age and gender rather than a phonological rule.

Nasals:

Voiced

/m/	labio-labial
/n/	apico-alveolar

When an apico-alveolar /n/ occurs before a velar plosive, its often realised as a velar [ŋ], e.g. /bank/ 'bank' is realised [baŋk]. In casual speech, if /n/ occurs before /b/ in word-initial cluster, it is frequently realised as bilabial [m], e.g. /nbiːʕ/ 'we sell' realised as [mbiːʕ]. If /n/ occurs between a front vowel and dental fricative /f/ it is a labio-dental [ɱ], /ʔin.ˈfa.lag/ 'it split' realised as [ʔiɱ.ˈfa.ləg]. In the presence of velars, /m/ has a rounding and raising effect on /a/, e.g. [ˈgu.mar] 'moon' and [ˈmug.la] 'frying pan'; compared to [dam] 'blood' and [mat.ˈruːs] 'full'.

Liquids:

Voiced

/ɾ/	apico-alveolar tap
/r/	apico-alveolar trill
/l/	apico-dental lateral

In KA, the alveolar trill is used for all /r/ geminates, such as the word /ˈma.rə/ 'once' and /ˈba.rə/ 'out'; whereas the alveolar tap was used in all other occurrences (e.g., /ˈdaː.ɾi/ 'my room', /brɑːʃ/ 'hair comb', /ˈma.ɾə/ 'woman'). The distinction between the alveolar trill /r/ and tap /ɾ/ is based on the environment where it occurs (more details in section 4.3.10 of Chapter 4).

Glides:

Voiced

/w/	close-back rounded
/j/	close-front unrounded

3.5.2. Geminates

Two types of geminates often occur in KA: the first type of geminate is part of the lexical root of the word, which is often lexically contrastive. For example, the KA minimal pair /ħa.ˈmaːm/ 'pigeons' and /ħa.mːaːm/ 'toilet' (more details in section 4.3.9. of Chapter 4). The second type results from a complete assimilation that occurs when two identical phonemes are adjacent in one syllable within a word (i.e., long phoneme), or two adjacent words in connected speech. Clear examples are illustrated in /na.ˈʤːaːr/ 'carpenter' and /mu.ˈda.ris/ 'teacher' where the medial consonant is doubled, that is *geminated*. Gemination is a very common pattern in both colloquial and modern standard Arabic. KA phonology has continuing developments arising from assimilation and dissimilations, which exhibits either partial or complete differentiation of features in adjacent segments. There are both believed to be diachronic and synchronic. Few examples were demonstrated above. However, additional aspect of this evolutionary process is *gemination*.

3.5.3. Consonant clusters

Consonant clusters are rarely studied in Arabic and the frequency of cluster occurrence is unknown for both adult and child Arabic speech. According to Al-Qenaei (2011), almost all possible consonant clusters are structurally permissible in KA. Data from the current study showed a total of 33 different types of consonant clusters were produced in word initial position, ten different types in word medial, and 30 different types in word final position. The frequency of target clusters in child speech will be presented in the results chapter (see section 5.5 of chapter 5).

3.5.4. Vowels

KA inventory has 13 vowels, which are the following:

      Short vowels: a, i, u, ɑ, ɒ, ɔ, ə, e
      Long vowels: aː, ɛː, iː, oː, uː

Only short vowels a, i and u and their long counterparts are attested in MSA, along with the diphthongs ai and aw. In KA, the MSA diphthongs ai and aw are almost always realised as long vowels ɛː and oː respectively (Al-Qenaie, 2011).

3.5.5. Syllable and word shapes

KA has eight attested syllable patterns (Al-Qenaie, 2011) listed below (C is consonant and V is vowel):

- CV   /ˈka.tab/   'he-wrote'
- CVC   /bas/   'enough'
- CVV   /ˈhaː.ða/   'this' +masculine
- CCV   /ˈbga.ra/   'cow'
- CVVC   /haːʧ/   'here-you-go' + feminine
- CVCC   /bard/   'cold'
- CCVV   /ʃfiː/   'what's wrong with him'
- CCVVC   /dlaːq/   'sock'

From the examples above, it can be seen that some words contain morphological roots, which in many cases attribute to the word length as well as syllable structure. In KA, words are generally one-to-three syllables in length. However, in the case of borrowings, and the presence of bound morphemes words may be as long as five or more syllables. The syllabic template of KA is illustrated in figure 3.2.
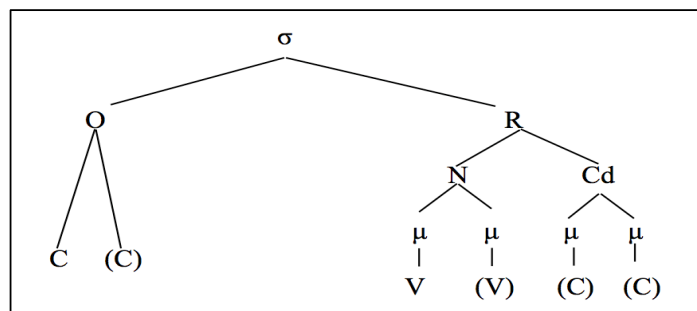
Figure 3.2: The syllabic template in KA

In KA, the word's morpho-phonological make up changes according to gender and tense. For example:

(1)　Stem noun /mad.risa/ (CVC.CV.CV) 'school':

a.　　/mad.ˈris.tiʧ/
　　　CVC.CVC.CVC
　　　 'your school'
+ feminine 2nd person possessive

b.　　/mad.ri.ˈsat.ha/
　　　CVC.CV.CVC.CV
　　　'her school'
+ feminine 3rd person possessive

c.　　/mad.ˈris.tik/
　　　CVC.CVC.CVC
　　　'your school'
 + masculine 2nd person possessive

d.　　/mad.ˈris.ta/
　　　CVC.CVC.CV
　　　'his school'
+ masculine 3rd person possessive

(2)　　Stem verb /raːħ/ 'go':

a.　　/ʔa.ˈruːħ/
　　　CV.CVC
　　　'I go'
present tense + 1st person

b.　　/truːħ/
　　　CCVVC
　　　'she goes'
past tense + feminine 2nd person

c.　　/raːħ/
　　　CVVC
　　　'he went'
past tense + masculine 2nd person

d.　　/ˈraː.ħat/
　　　CVV.CVC
　　　'she went'
past tense + feminine 2nd person

From the above examples, it can be seen that both noun and verb shapes change according to morphological structures. In example (1) the noun /mad.ri.sa/ illustrate the changes that occur in word shape. In example (1) a and b word shapes changed according to 2nd and 3rd person possessive, while gender remained the same. The same applies to c and b. However, comparing b and d, a syllable was added based on gender. Those examples illustrate the morpho-phonological complexity of KA. Data collected in the current study show great diversity of word shapes; there were 240 different word shapes targeted by KA speaking children under the age of 3;4 (see full list of common target words in Appendix A). Children are expected to omit morphological structures at this age, and therefore are expected to produce far more variants of word shapes in spontaneous speech.

3.5.6. *Stress patterns*

Arabic stress patterns form another knowledge gap in the current literature; one possible reason is that changing the stress pattern of an Arabic word does not affect the lexical information of the spoken word. However, rules governing stress patterns do exist. The stress pattern in KA resembles that of Jordanian Arabic and Egyptian-Arabic in many ways (J. Watson, 2011). The stress will fall on the penultimate if the penultimate syllable is heavy, as is shown below in example (1); otherwise it will fall on the antepenultimate syllable, as is shown in (2). The one complication to this pattern is that final syllables will bear stress if they contain a long vowel or have a final consonant cluster, as is shown in (3). Bold text indicates stress in the following examples:

1. Penultimate stress:

/ˈhaː.ða/	**CVV**.CV	'this' + masculine
/ˈdʒib.na/	**CVC**.CV	'cheese'
/ˈʔar.nab/	**CVC**.CVC	'rabbit'
/ˈdaːx.la/	**CVVC**.CV	'inside-it'

2. Antepenultimate stress:

/gil.ˈnaː.hum/	CVC.**CVV**.CVC	'we said-it' + plural
/naː.ˈkil.ha/	CVV.**CVC**.CV	'we-eat-it' + feminine
/ʔi.ˈθːaʕ.ləb/	CV.**C:VC**.CVC	'the-fox'
/ðo.ˈbːaː.nə/	CV.**C:VV**.CV	'fly'
/maːt.ʕər.ˈfiːn.hʊm/ CVVC.CVC.**CVVC**.CVC 'you-don't-know-them' + feminine

3. Final stress:

/ mi.ˈnːiː/	CV.**CVV**	'here'
/to.ˈfːaːħ/	CV.**C:VVC**	'apples'
/səl.ħu.ˈfaːt/	CVC.CV.**CVVC**	'turtle'
/ʕin.da.ˈjːaː/	CVC.CV.**C:VV**	'he-has-it' + masculine
/ʔa.ˈʕarf/	CV.**CVCC**	'I-know'

In disyllabic words, if the vowel length is equal, the stress tends to fall on the penultimate syllable; for example:

/ˈsˤa.gɛr/	**CV**.CVC	'eagle'
/ˈba.ħar/	**CV**.CVC	'sea'
/ˈʔaz.rag/	**CV**.CVC	'blue'

It is important to note that prosodic conditions also influence the stress placement in KA. Word stress can also change based on the word position in a statement or a question. For example;

(b)   i. ˈhaː.ða   ˈqa. la.mi   ii.   ˈhaː.ða   qa. la. ˈmi

       'this (is)   my-pen'   '(is) this   my-pen?

       CVV.CV   **CV**.CV.CV   **CVV**.CV   CV.CV.**CV**

         statement   *question*

In example (b), there is apparent stress shift to final syllable in question compared to statement sentence. This prosodic stress shift pattern was also found in Jordanian Arabic (de Jong & Zawaydeh, 1999). This variability in stress placement is beyond the scope of this study and will be aimed for in future research.

Based on data collected for the current study, intra-dialectal variation in KA word stress patterns was observed. The general pattern of stress placement in Arabic is that the last heavy syllable is typically stressed. Different social groups seem to place emphasis on different syllables on the same word. For example:

(a)   i. /mad.ˈri.sa/   ii. /ˈmad.ri.sa/   'school'

      CVC.**CV**.CV   **CVC**.CV.CV

In example (a), (i) the stressed is placed as iamb syllable (i.e. penultimate stress), most KA speakers would place stress as in (i). However, most Bedouin descendant KA speakers shift the stress to a trochee (i.e. antepenultimate stress) because there is a requirement that the main stress falls on a heavy syllable whenever possible.

3.5.7.   Phonotactics of KA

The effect of pharyngealised sounds in KA spreads over neighbouring vowels and consonants, with dialect specific rules regarding the extent and the direction of emphasis (pharyngealisation) spread. Back consonants such as /x/

can also lead to a velarisation and/or pharyngealisation effect, as in example (1) below.

(1)　　　　　MSA　　　　　　　KA

　　　　　　/xaːl/　　　　　　　/xaːɫ/　　　　　　　'uncle'

　　　　　　/sˤawt/　　　　　　/sˤɑːtˤ/　　　　　　'sound'

However, there are some exceptions to this rule. For example, in both /ʔaɫːaː/ 'God' and /ʔɑbɫɑ/ 'teacher', the medial /l/ is realised as pharyngeal /l/ (i.e. /ɫ/) without the existence of clear attributing pharyngeal feature. For the fist example, the word Allah 'God' is a word that is closely related to religious beliefs which is often resistant to change (Elhadj, Aoun-Allah, Alsughaiyer, & Alansari, 2012). Whereas for the latter example, the word /ʔɑbɫɑ/ 'teacher' is borrowed from Turkish meaning 'my big (in age) sister' (Mohammad, 2009).

A second process is the assimilation of definite article –ʔal of MSA, which is realised as –ʔil in KA. This process is attested across all Arabic dialects as well as in MSA. The article is assimilated to word-initial coronal consonants /t, tˤ, d, s, sˤ, z, θ, ð, ðˤ, r, ʃ, ʧ, ʤ, l, (ɫ), n/, and the output is a false geminate (Yousef, 2013) as in example (2) below.

(2)　　　　　MSA　　　　　　　KA

　　　　　　/ʔaːsːaːjːaːra/　　　/ʔiːsːaːjːaːra/　　　'the car'

　　　　　　/ʔaːtˤːaːjːara/　　　/ʔiːtˤːaːjːara/　　　'the airplane'

In summary, KA is the spoken dialect of Arabic that is used in Kuwait and several surrounding countries. KA consists of 32 phonemic consonants, which incorporate all Arabic consonants of other dialects. The syllable structures of KA are similar to those of MSA, which allows many types of clusters in all word positions. KA shares the penultimate stress pattern with other dialects of Arabic.

The study of developmental phonology holds its own caveats when researchers try to compare the child's speech to the adult's form. It is essential to consider the difference between adult and child language especially when dealing with a

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language of high complexity such as Arabic, The complex morpho-phonological structures of Arabic, as well as its diaglossic nature, makes the comparison between adult and child's speech even more complicated. Therefore, one has to consider all dialectal variants that occur in adult's speech, which is often reflected in the development of child speech. For instance, dialectal changes that occur in KA adult's speech should not be considered as errors in child's speech.

Chapter 4:
Methodology

4.   Chapter Four: Methodology

This chapter presents the research methodology used to derive information about phonological development of Kuwaiti Arabic-speaking children between the ages of 1;4 and 3;7.

4.1.   Aims of the study

Research in the area of Arabic language acquisition is very limited. To date, the published data are mostly small-scale studies (McLeod & Bleile, 2003). The largest normative data available was based on 130 Jordanian Arabic children, conducted in Jordan by Amayreh (1994). Studies of phonological development are limited to a small number of Arabic dialects, most of which are small-scale research studies (e.g., Egyptian: Ammar and Morsi, 2006; Saudi: Faraj, 1988; and Palestinian: Ravid and Hayek, 2003). In order to represent the diversity of typical developmental norms in Arabic phonology, large-scale studies are considered necessary. This emphasizes the need for more research that focuses on the Arabic population. Information needed by speech-language therapists working with Arabic-speaking population is limited (Amayreh & Dyson, 2000). This study will aim to illustrate several aspects of the phonological development of Kuwaiti Arabic.

4.2.   Research questions

In the current study, research questions were devised to identify typical phonological acquisition and developmental patterns of children between the ages of 1;4 and 3;7 speaking Kuwaiti-Arabic as a first language. This will be in the form of answering the following specific questions:

a. At what age do Kuwaiti-Arabic speaking children spontaneously produce sounds of their first language? More specifically, what are the ages of *customary production, mastery,* and *acquisition* (for definitions see section 4.4.3) for each consonant?

b. What are the *age-appropriate, occasional*, and *rare* error patterns (defined below) occurring naturally in the spontaneous speech of Kuwaiti children?

c. What are the syllable structures that occur in real words produced spontaneously by Kuwaiti-Arabic speaking children in a naturalistic context?

d. How do Kuwaiti-Arabic speaking children compare to other Arabic speaking children in terms of phonological acquisition and developmental sequence?

e. How do Kuwaiti-Arabic speaking children compare to children speaking other languages in terms of phonological acquisition and developmental sequence?

The current study will provide essential information on the acquisition order of phonological patterns that occur in the speech of children learning Kuwaiti-Arabic. The outcomes of this study will provide essential data on the phonological development of children aged 1;4-3;7 and highlight the influence of the ambient language on the developmental patterns. What is special about Kuwaiti-Arabic is that it has a rich consonant inventory which combines the consonants found in MSA with dialectal variants and other sounds that result from the influence of loanwords. For example, Kuwaiti-Arabic shares the /g/ and /ʧ/ phoneme with English. The similarities and differences between Arabic and English will form solid grounds needed for exploring the development of universal and language-specific patterns.

4.3. Data collection

4.3.1. Participants

The data collection took place in Kuwait. A total of 70 children, in groups of ten, were sampled from the general Kuwait population. Residents of Kuwait originating from neighbouring countries were excluded. The subjects were randomly selected from variable ethnic backgrounds and social classes, concentrating on inner city population. The age groups were selected as a continuum to Ayyad's (2011) study (age 4;0-5;0), which was in progress at the

time when this study took place. The sample was divided into seven gender-balanced subgroups with the following age ranges: 1;4-1;7, 1;8-1;11, 2;0-2;3, 2;4-2;7, 2;8-2;11, 3;0-3;3 and 3;4-3;7. According to Watson and Scukanec (1997), the six-month increments may not be specific enough to capture the phonological growth that takes place in children younger than three years; therefore, three-month age increments were used in the current study.

4.3.2. Subjects recruitment

Informed written consent was obtained from directors of randomly selected Arabic speaking childcare centres in Kuwait. Information packages were sent out to parents of children attending the childcare centre. Parents interested in participating in the project were contacted by phone to arrange a meeting and answer further queries. Parents who took part in this research were asked to refer other families who may be interested to take part. Referred families were contacted over the phone by the researcher who provided further information and explained the aims of this research. Subject recruitment limitations are discussed in section 4.6 of the current chapter.

Written consent was obtained prior to the planned recording session from the child's parent or legal guardian for both video and audio recordings. All parents were provided with hearing screen test results and short debriefing meeting after the recording session. Case history information was collected concerning birth and developmental history, health, and social information to ensure the population was representative.

4.3.3. Elicitation procedure

Spontaneous speech sample was audio and video recorded on a single occasion. The parent was instructed to interact spontaneously with his or her child for 30 minutes. A set to rubber toys and picture books were made available during all recording sessions. The parent/child spontaneous interaction was digitally recorded with an Edirol R-09HR Handheld SD Recorder and a Shure PG14/PG185 Lavalier wireless microphone system attached to a custom made vest and connected wirelessly to the recorder. The vest was

made to hold the microphone transmitter on the child's back and the lavalier microphone was attached approximately 10-15 centimetres below the child's chin.

All children were offered a screening hearing assessment in the form of free-field audiogram to ensure adequate hearing necessary for the child's speech development. The researcher used an Interacoustics PA5 Kamplex KS5 portable paediatric audiometer to perform the screening test in a quiet room prior to recording the speech sample. They each passed a 25- or 30-dB pure tone hearing screening test at 500, 1000, and 4000Hz.

A number of picture books and rubber toys (duck, fish, frog and turtle) were made available for the parents to use during the recording session. The parents were encouraged to use the provided toys and books when the child is not cooperative, especially near the end of the 30-minute session.

The recording sessions took place mostly in the family home, however, on several occasions where a quiet space was not available at the family place, the recordings were done in a quiet room kindly provided by Al-Khurafi Activity Kids Centre. Al-Khurafi Activity Kids is a charity run centre that provides disabled children with the opportunity to learn through play and fun within a safe and enjoyable environment. The manager of the centre was approached and kindly offered a room within the premises to be used for the research purposes. All data were exported from the digital recorder to a laptop, then onto an external hard disk for safe back up.

4.3.4. Maternal interviews and mothers' role in data elicitation: Naturalistic observational method

Parents were asked to play with the child as they normally would on a typical day. During the session parents were asked to elicit the words/utterances that they think the child already produces where possible. Parents and children in Kuwait often speak English. This practice is often socially acceptable in the

current Kuwaiti culture. However, the parents were informed that the study was on Arabic speech development and were encouraged to use Arabic as much as they can.

The children's utterances were spontaneous. The type of interactions that were captured in the recordings were either free play with the parents, elicited speech while playing with toys, or elicited speech while viewing picture books. The parents were asked to use picture books to elicit speech by asking the child to name pictures where possible.

It was emphasised that the parents should not produce the words themselves, otherwise the child may simply imitate, and for that the researcher proposed a few ideas on how to elicit these utterances in an indirect way. For example, the parent may point to a familiar item (toy or object) and ask the child to name it; then ask the child simple questions to elaborate (e.g., what is this? Yes, it is a fish. Where does it live? What colour is it?). The researcher left the room if the child was being distracted by her presence.

4.3.5. Data preparation

The children's emerging phonological inventories were documented while keeping track of their developmental patterns and individual differences. The data sessions were orthographically and phonetically transcribed before analysis. All recording were transcribed using the PHON computer program (Byrne et al., 2008). The audio recording was used primarily for the phonetic transcription while the video recording was used to clarify unintelligible audio recordings. The sound file was segmented into the different utterances produced by the child prior to actual transcription.

4.3.6. Transcription issues

The author who is a native speaker of KA transcribed the data sessions orthographically and phonetically using the International Phonetic Alphabet (IPA) revised 2005. The data was transcribed and analysed using a computer program PHON (Byrne et al., 2008). Seven samples (10%) were sent to an

experienced phonetician in Kuwait who is a native speaker of Arabic; the inter-rater reliability was 95% with the author's transcriptions for consonants. Reliability was considered only for consonants for this thesis; vowels were deferred for future studies.

4.3.7. Word Identification

Words were identified using the criteria proposed by Vihman and McCune (1994). The proposed criteria accounts for; the *context* in which the vocalisation may occur, the vocalisation *shape* and how it relates to the adult form; and its *relation to other* vocalisations.

For the context-based criteria, vocalisations were identified as words when their meanings were clearly identified in contexts or by the mother, or when the child used them more than once with similar phonological shapes across different uses. For example, when a child produced the word /mi.jaw/ 'cat-sound' while pointing to a picture of a cat, this vocalisation was counted as a word. However, when the child imitated a response of a verbal stimulus, the utterance is not considered as a word.

For the shape criteria, vocalisations were counted as words if more than two segments were matched to the adult form, or when the prosody of the vocalisation matched the adult target. For example, when the target word /səl.ħʊ.ˈfaːt/ 'turtle' is realised as [fəʊ.ˈhaːt] the word is counted despite the apparent syllable deletion and assimilation error.

Vocalisations were identified as words when vocalisations were instances of imitation produced with apparent understanding, when all instances of vocalisations shared the same phonological shape, or when all uses of vocalisations occurred in contexts that plausibly suggest the same word. For example, one child produced an unknown word /ˈguː.ma/ in five different occasions during a 30-minute session, each time the word was produced it was understood and repeated by the mother. The video recording showed that the child was pointing to a bird-like toy each time she produced the word. The

vocalisations were considered a word as they had a consistent phonological shape in all five instances.

4.3.8. Language tagging

Kuwaiti Arabic speaking children tend to use both Arabic and English languages in their normal environment. A few children still showed preference for English words (e.g. dog, cat, car) in addition to character names (e.g. Superman, Spiderman, McQueen). For the purpose of data analysis all English names were identified as Arabic words as they do not have Arabic equivalents, and were produced by adults with Arabic-like phonetics. For example, Spiderman /spaɪ.dəɹ.mæn/ often produced as [sbaj.der.maːn] by Arabic speaking adults, because the voiceless /p/ does not occur in Arabic andis often realised as voiced [b]. All other words of English origins were tagged for selective analysis. All words were included in the frequency analysis, whereas English words were excluded from the accuracy analysis. Onomatopoeic words such as /mi.jaw/ 'cat-sound', /haw.haw/ 'dog-sound', /ʔɑm/ 'food' or 'eat', and /baːʕ/ 'sheep-sound' are commonly used in child directed speech, therefore such words all counted as Arabic words and were included in data analysis.

4.3.9. Geminate transcription

Geminates occur frequently in Arabic. The term geminate in phonology refers to a long or doubled consonant that contrasts phonemically with its shorter or singleton counterpart (Crystal, 2003). Geminate consonants are sometimes transcribed by (*a*) a sequence of two identical phonemes; (*b*) with single consonant followed by the IPA length mark; or (*c*) with two identical consonants separated with a syllable boundary marker. In this study, the geminates were transcribed as a single consonant followed by the IPA length mark, and demonstrated in the following examples:

(*a*)	(*b*)	(*c*)	
/sad.rejja/	/sad.re.jːa/	/sad.rej.ja/	'baby bib'
/ħə.mmaːm/	/ħə.mːaːm/	/ħəm.maːm/	'bathroom'
/fi.ʧʧa/	/fi.ʧːa/	/fiʧ.ʧa/	'open it'+ masculine

The geminate contrast is commonly found in languages such as Arabic and Italian, as exemplified by the minimal pairs in (1) and (2), respectively

(1)   Arabic geminate contrast:

/ħaˈmaːm/   'pigeons'

/ħaˈmːaːm/   'bathroom'

(2)   Italian geminate contrast (Davis, 2011, p.837):

/fato/   'fate'

/faˑtːo/   'fact'

4.3.10. Tap and trill distinction in transcription

The /r/ phoneme production is variable in manner and place of articulation in different dialects of Arabic. Omar (1973) treated all Egyptian Arabic /r/ as taps, whereas Ayyad described all /r/s as trills in Kuwaiti Arabic. Saleh et al. (2013) examined speech samples of 50 adult speakers of Egyptian Arabic. Spectographic analysis of the samples showed that taps and trills are often influenced by word context (e.g. position, adjacent vowel and consonants). They found that /r/s are produced as trill in geminate environments, in word-medial syllable-final position with preceding open unrounded vowels (e.g. /ba.ra/ 'outside') or followed by back vowel (/ba.ruːħ/ 'I will go'). In the current study the distinction between the alveolar trill /r/ and tap /ɾ/ was based on the word context where it occurs. The alveolar trill was used for all /r/ geminates; whereas the tap was used for all other occurrences. For example, in the minimal pair /ˈma.ra/ 'once' and /ˈma.ɾa/ 'woman', the first /r/ was treated as a geminate and the second as a tap.

4.4.   Analysis procedures

Children's production of speech-sounds was examined in word contexts (i.e. phonological analysis) in terms of the accuracy of their production and the percentage of children in an age group who reached the targeted level of accuracy (as in Smit et al., 1990). The children's emerging phonological inventories were documented while keeping track of their developmental patterns and individual differences. The frequency of occurrence and the production accuracy were calculated for all consonant singletons and

consonant clusters in four possible word positions. The following procedures
were carried out:

4.4.1. Word count and languages

All Arabic and English words were tagged in the transcript. All attempted targets
were included in the analyses and the percentage of languages used was
calculated accordingly. At this stage of analysis, words of both languages were
included to determine percentages of languages that are used spontaneously
by KA speaking children.

4.4.2. Frequency calculations (Target words)

The frequency of occurrence was calculated for consonants and syllable
shapes of target words that were attempted by children's spontaneous speech
samples. Number of occurrences and frequency percentage were calculated for
each consonant, consonant cluster and syllable shape (see examples below).
All consonants and clusters attempted by children were included at this stage of
analysis. For each consonant, cluster, and syllable shape the percentage of
occurrence was calculated using the following formula:

$$\frac{No.Occurrences}{TotalOccurrences} = OccurrenceFrequency$$

4.4.3. Production accuracy calculations

Consonants that were attempted at least once by five out of ten children within
one age group are considered as acquired following three criteria:
- *Mastery production*: when a sound was produced accurately in at least 90%
of the targets attempted by more than five children in given age group;
- *Acquisition production*: when a sound was produced accurately in at least
75% of the targets attempted by more than five children in given age group;
- *Customary production*: when a sound was produced accurately in at least
50% of the targets attempted by more than five children in given age group;

For each age-group, the Percentage Correct Consonant (PCC), was calculated using the following formula:

$$\frac{No.Correct}{TotalOccurrences} \times 100 = PercentageCorrectConsonant(PCC)$$

Calculations are based on total number of targets (frequency count) rather than total number of children within a group (cf. Amayreh & Dyson, 2000). Because children produced consonants in variable frequencies, and the actual frequency of consonant occurrence in Arabic is unknown, the number of attempted targets produced in by a group of children is assumed to represent the number occurrences in which the consonant occur normally in children's speech.
For instance, the production accuracy of the bilabial stop /b/ for the 3;4-3;7 age group, is calculated as per the following example:
Given that /b/ is produced 4,083 time by all children and was produced 3,838 times correctly by children in 3;4-3;7 group:

$$\frac{3,838}{4,083} \times 100 = 94$$

That is, children in the named group produced /b/ correctly at 94% of total number of times it was attempted.

Consonants that were attempted by less than five out of ten children in a group were excluded from the accuracy calculations. The criterion was set to ensure that each consonant has to be produced by at least 50% of children in a group of ten. This would allow for potential individual differences between children within the group. For example, if one child of the group produced a consonant X once, and it happened to be produced accurately; the PCC of consonant X would be 100%, which would result in false positive finding.

4.4.4. Error pattern calculations

Phonological error patterns are defined as consistent differences between child and adult realisations of the target words. They are a general tendency that affects a group of sounds. For each age group, the percentage of error pattern occurrence was calculated using the following formula:

$$\frac{No.\,Error\,Patterns}{Total\,Target\,Words} \times 100 = Error\,Pattern\,Occurrence\,Percentage$$

The number of error patterns that were produced by two different children in a group was divided by total number of target words attempted by the group and multiplied by hundred to get the percentage of error pattern occurrence.

For an error pattern to be included in this analysis, an error has to be exhibited by at least two out of ten children in an age group. This criterion was set to avoid the possibility of auditory misperception. For example, a child may learn a word that he or she misperceived and was stored in their lexicon in error, the child may not be aware of the production error and produces it as it is. However, it is less likely that two children within a group misperceive the same consonant, but are more likely to produce the same error if the consonant was less phonetically salient or more complex; therefore, if two or more children produced the same error, the production error is more likely to be faithful to child's lexical representation.

Error patterns were then categorized in three groups:

1. *Age appropriate patterns:* when an error pattern occurred in at least 10% of the target words attempted by two or more children in given age group;
2. *Occasional patterns:* when an error pattern occurred in at least 5% of the target words attempted by two or more children in given age group;
3. *Rare patterns*: when an error pattern occurred in less than 5% of the target words attempted by two or more children in given age group.

In earlier studies of developmental error patterns, the error has to be exhibited in at least 2 different lexical items to eliminate misperception (McIntosh & Dodd, 2008; Dodd et al., 2003). For example, if the child misperceives the word X, and learns it's incorrectly; the child is likely to produce the X word in error without knowing the correct form of this specific word. In the current study, because the data was produced spontaneously, the error had to be produced by two

different children in a group where the two words are less likely to be identical. For example, if two different children produced one error pattern (e.g., fronting of /k/), the first child produces the error in /ˈkam.bal/ 'blanket' → [ˈtam.bal]; while the second one produces it in /ˈka.bat/ 'cupboard' → [ˈta.bat]; thus, the same error is less likely to be produced in the same word.

4.4.5. Target word shape, length and stress pattern analysis

This part of data analysis differs from earlier sections; similar to consonant frequency analysis, it looks at words that are targeted in child speech rather than actual realisations of those words. This analysis was limited to target words for several reasons; first, Arabic language is rich with bound morphemes that are interwoven into word structure; and it is expected that children omit some morphological structures that add to the word shape complexity. Second, stress placement in KA is often influenced by sentence prosody in different Arabic dialects, including KA. Data in the current study was collected from children of KA speaking families with different dialectal variations. Because intra-dialectal variation of KA was never described in the current literature, all variants were treated homogenously in the current study. Possible variants were transcribed according to the parents' realisation of the target word rather than the researcher's realisation (who is a native KA speaker).
Analysis of target word comprise of the following:

  a. The number of target words produced by each age group;
  b. number of different target word shapes attempted by each age group;
  c. For each age group, the number of target words were counted and grouped by word length;
  d. and for each word shape, the overall frequency of occurrence was calculated according to the following formula:

$$\frac{No.Occurrences}{TotalOccurrences} = OccurrenceFrequency$$

4.5. Individual variability considerations

It is important to note that the range of words sampled and transcribed did not guarantee equal opportunities for the child to attempt all the consonants, which may be due to either the child's active selection or limited range of vocabulary. Furthermore, the data collected were of spontaneous interactions; therefore, the occurrence of target segments varied from one child to another, whether a child would have a chance to use a segment or how many times a segment would occur. There may be evidence of 'avoidance' strategies in the children's phonological development. The mere non-existence of a feature or a segment in children's production does not mean that the child does not have the skills to produce it.

The collected data incorporates many variable factors, some of which are individual to the child and some are environmental or a combination of both factors. For example, if a child was recorded near his naptime, he or she may produce fewer words than a child who just woke up. Other factors may be determined by the parent's ability to stimulate the child and maintain his/her interest during the recording sessions. Many children were used to spending long periods of time with their nannies rather than the parents, hence the parent-child interaction was not as naturalistic as it was expected to be. These factors must be taken into consideration when accounting for the age of acquisition, and more importantly the issue of individual variations and the criteria used for identifying consonant acquisition.

4.6. Data collection limitations

As in most Arab countries, cultural and social standards play major role in the population behaviour. A few families refused to take part of the study because they do not want to be video recorded. The fear of their pictures appearing in public was clearly stated by some families. In that case, we reassured the family that their video recording was kept safe and will not be viewed by anyone other than the researcher. In some cases we had to zoom-in on the child's face and immediate surrounding without the parent appearing in the video.

Subject recruitment procedures were modified to gather as many subjects as possible in a short period of time. The initial plan is to contact nurseries and send out information packages to parents with the researcher's contact number and email. Parents who were interested to take part in the study were encouraged to report back to the class teacher. However, this was soon changed, as the response rate was less than expected. In one case, only one out of 70 parents agreed to participate in the study. Again, the fear of social stigma was addressed here, as some parents refused the idea of having their children's speech abilities examined and labelled by a specialist.

We found that contacting families directly and text messaging worked better in subject recruitment process. I was invited to a parent-teacher event in few daycare centres and was introduced to parents verbally by the director. We found that the parents were more welcoming and willing to take part in the study after meeting the researcher in person. After each recording session, we asked the parents if they could nominate other families who may be willing to participate in this research.

Interestingly, we have found that parents of boys were more concerned about their son's speech development than parents of girls of the same age. Therefore, parents of boys showed interest in the study and were less likely to miss the recording session. This was reflected on the progress of the data collection. The boys groups recordings were completed before girls groups of the same age in most of the age groups.

The following chapter will present the findings derived from the above analysis procedures and will be further discussed in Chapter 6.

Chapter 5:

Results

5. Chapter Five: Results

This chapter presents analysis findings in six major focus areas in the following order: participants' demographics and spoken languages; consonant and word shape frequency; consonant acquisition; the development of error patterns, and consonant cluster acquisition in KA.

5.1. Participants' demographics and spoken languages

Findings in this section present the participants' demographic details, word counts and languages used spontaneously by KA speaking children.

5.1.1 Participants' demographic details

Table 5.1 shows the age groups of participants. A total of 70 children enrolled in this study subdivided into seven age groups with three-month intervals.

Age (Year;Month)	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-3;11	3;0-3;3	3;4-3;7
Age range (months)	16-19	20-23	24-27	28-31	32-35	36-39	40-43
Number	10	10	10	10	10	10	10
Gender: Boys/Girls	5/5	5/5	5/5	5/5	5/5	5/5	5/5
Minimum age (months)	16	20	24	28	32	36	40
Maximum age (months)	19	23	27	31	35	39	43
Mean age (months)	17.6	21.5	25.1	29.9	33.75	38.4	41.75
Median age (months)	18	21.5	25	30	34	37	42
SD	± 1.19	± 1.24	± 1.12	± 1.12	± 1.07	± 1.05	± 1.21

Table 5.1: Participants' demographic details.

All children spoke the Kuwaiti dialect of Arabic. All age groups were gender-balanced consisting of five boys and five girls.

5.1.2 *Languages used in KA children spontaneous speech*

Table 5.2 shows the number of words produced by children in each age group.
Interestingly, the number of produced words nearly double by the age of 2;4
compared to younger groups (aged between 1;4 and 2;3) which reflect marked
increase in vocabulary development.

Age group	Arabic word count (%)		English word count (%)		Total words
1;4-1;7	1,158	(90%)	123	(10%)	1,281
1;8-1;11	1,052	(91%)	103	(9%)	1,155
2;0-2;3	1,752	(98%)	44	(2%)	1,796
2;4-2;7	4,230	(98%)	67	(2%)	4,297
2;8-2;11	4,053	(99%)	32	(1%)	4,085
3;0-3;3	3,572	(96%)	160	(4%)	3,732
3;4-3;7	4,227	(99%)	35	(1%)	4,262
Total	20,044 (97%)		564	(3%)	20,608

Table 5.2: Languages used in KA children's spontaneous speech

As seen in table 5.2 above, the children in this study produced more than
20,000 words out of which 97% of the total words were Arabic and only 3%
were English. Interestingly, table 5.2 shows that the younger groups used
English words more frequently compared to the older groups. One possible
explanation could be that children under the age of two are more likely to stay
at home with English speaking nannies rather than attending mono- or bilingual
nurseries. Therefore, younger children are often exposed to both Arabic and
English languages at home.

5.2. **Frequency analysis**

The frequency of consonant occurrence in a language is believed to have great
impact on the child development of speech sounds (Demuth, 2007; C. Levelt et
al., 2000; Levitt & Healy, 1985). The occurrence frequency is well documented
for many of the world's languages (English: Locke, 1983); however, it is still
considered unknown for the Arabic language and its dialects. In an attempt to
identify the frequency of consonant occurrence in KA, spontaneous speech
samples of KA speaking children were used as a proxy for the sounds that are
used by KA adults.

The frequencies of occurrence of targets used by KA speaking children in spontaneous speech are presented below as the following: In figures 5.2 and 5.4, the number at the end of each column represents the percentage in which the sound occurred in target words attempted by all age groups. (i.e., number of occurrence divided by total number of target sounds multiplied by 100).

The frequency of occurrence was computed on the basis of word type information (type frequency) or word token information (token frequency). Two kinds of frequencies were calculated for all consonants produced by KA speaking children and presented below. Overall frequencies were calculated for all target types (N= 2,806) and tokens (N= 20,044) in all word positions collectively. Context specific type and token frequencies were calculated in three word positions: word-initial, word-medial , and word-final position. The following figures illustrate the distribution of KA consonants production manner. Type and token frequencies will be compared near the end of this section.

5.2.1. Type frequency

Type frequency was calculated for consonants and word shapes that were targeted by all groups of KA speaking children. The frequency of occurrence was computed for consonantal groups (classified according to production manner) in all word positions and for each consonant individually.

Figure 5.1 illustrates the type frequency of all groups of KA consonants grouped according to production manner.
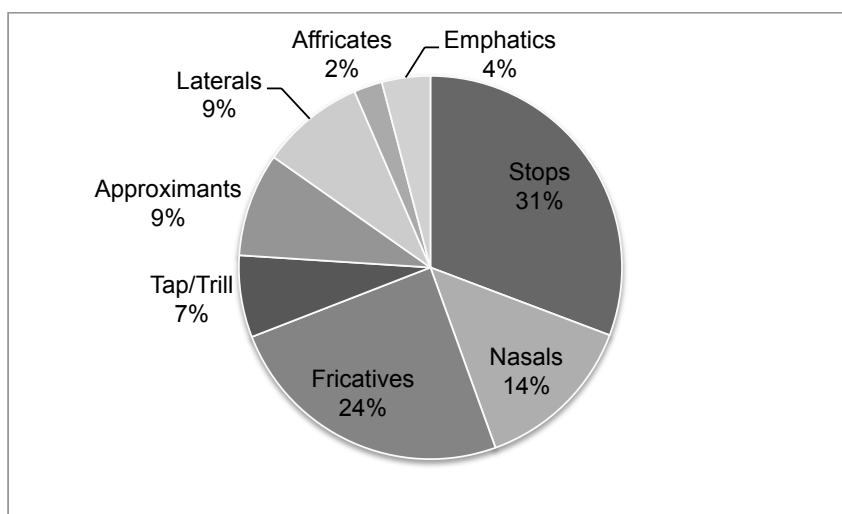
Figure 5.1: The distribution of KA consonant types in target words

It can be seen that stops and fricatives are the two most frequently targeted consonants in KA child speech, with occurrence frequencies of 31% and 24% respectively, followed by nasals (14%), approximants (9%), laterals (9%), and taps/tills (7%). Emphatics and affricates were the least frequently targeted consonants (4 % and 2% respectively).

The following chart shows the type frequency of occurrence of target consonants that are used by KA speaking children in spontaneous speech regardless of word positions.

Figure 5.2 shows that /l/ is the most frequently used consonant in KA spontaneous speech (8.5%), followed by /n/ (7.89%) and /b/ (6.97%). Interestingly, an earlier study carried out by Amayreh and Dyson (1998), suggested that the high occurrence frequency of /l/ in Arabic can be accredited to its early acquisition by children acquiring Jordanian Arabic compared to those acquiring English; however, Amayreh and Dyson did not provide frequency data to support their claim. Data presented in the current study is the first of its kind to support Amayreh and Dyson's proposal of the positive influence of frequency on acquisition rate of /l/ consonant.
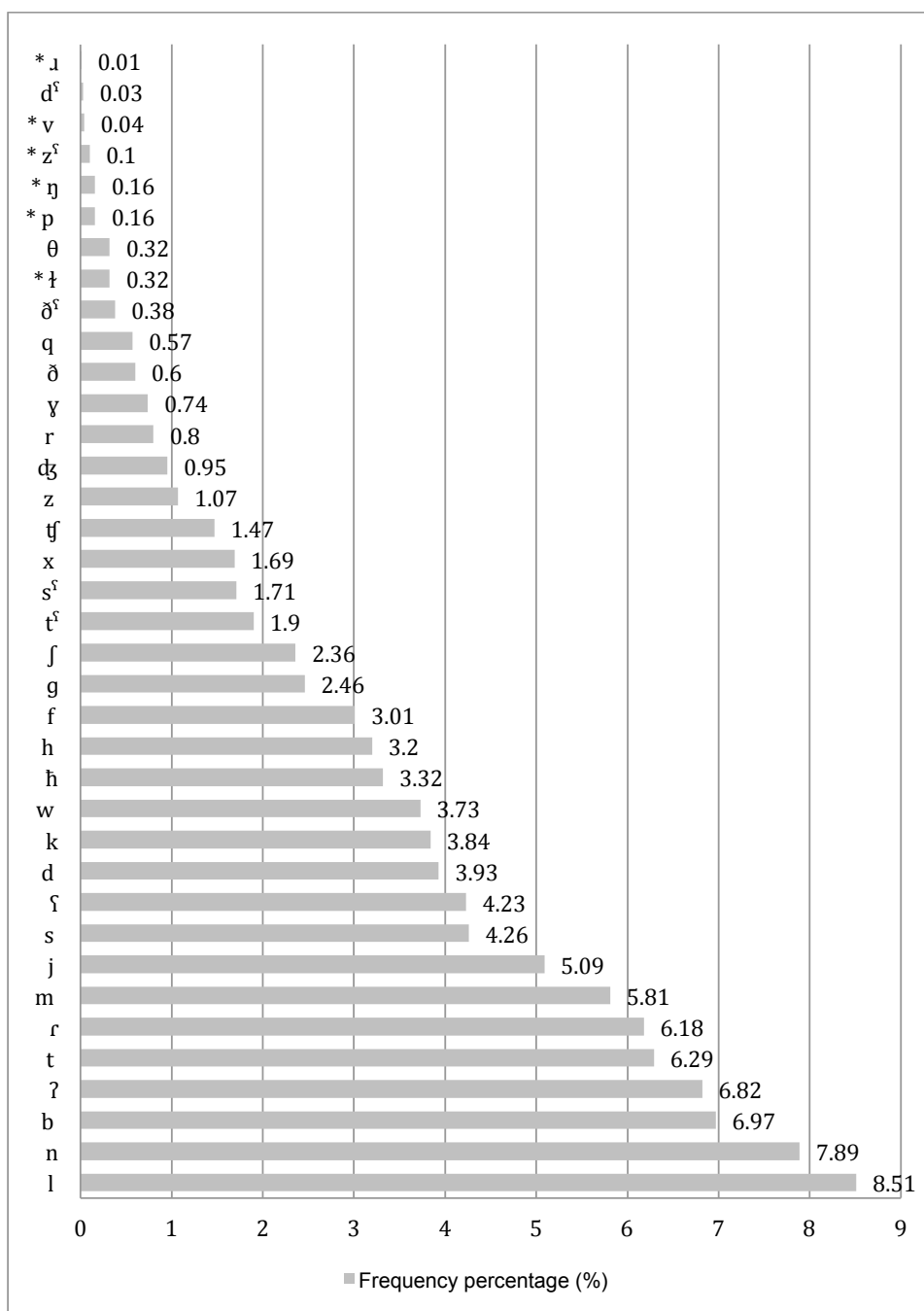
Chart showing consonant frequency percentages (%):

Consonant	Frequency percentage (%)
* ɹ	0.01
dˤ	0.03
* v	0.04
* zˤ	0.1
* ŋ	0.16
* p	0.16
θ	0.32
* ɫ	0.32
ðˤ	0.38
q	0.57
ð	0.6
ɣ	0.74
r	0.8
dʒ	0.95
z	1.07
tʃ	1.47
x	1.69
sˤ	1.71
tˤ	1.9
ʃ	2.36
g	2.46
f	3.01
h	3.2
ħ	3.32
w	3.73
k	3.84
d	3.93
ʕ	4.23
s	4.26
j	5.09
m	5.81
ɾ	6.18
t	6.29
ʔ	6.82
b	6.97
n	7.89
l	8.51

* Marked consonants are considered as non-Arabic, but occur normally in adult speech of KA as a result of phonological assimilation or in intra-dialectal variations. A list of target words (types) can be found in appendix A.

Figure 5.2: Overall target consonant frequencies in spontaneous speech samples of KA speaking children (Type Frequency).

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The frequency of Arabic word shapes has rarely been described in the current literature. Table 5.3 shows the type frequency of target words used in spontaneous KA child speech. For each word length category, all word shapes that occurred in more than 1% of the total number of words are listed according to frequency of occurrence.

Syllable count	Word shape	No. Occurrences	Frequency
1-syllable	CVVC	124	4%
	CVC	67	2%
	CCVVC	54	2%
2-syllables	CVC.CVC	161	6%
	CV.CVVC	155	6%
	CVV.CV	135	5%
	CVC.CVVC	116	4%
	CV.CVC	113	4%
	CVC.CV	106	4%
	CVV.CVC	96	3%
	CV.C:V	86	3%
	CV.C:VVC	71	3%
	CV.CV	45	2%
	CV.C:VC	44	2%
	CVC.CVV	44	2%
	CVVC.CV	44	2%
	CV.CVV	39	1%
	CV.C:VV	28	1%
	CCVV.CV	23	1%
	CVVC.CVC	18	1%
	CVV.CVV	18	1%
	CCV.C:VC	15	1%
3-syllables	CV.CVV.CV	106	4%
	CV.C:VV.CV	68	2%
	CVC.CVV.CV	41	1%
	CVC.CV.CVVC	38	1%
	CV.CVC.CV	31	1%
	CV.CV.C:VC	30	1%
	CVC.CV.CV	28	1%
	CV.CV.C:V	27	1%
	CV.CVV.CVC	26	1%
	CV.C:VC.CV	21	1%
	CVC.CV.C:V	19	1%
	CVC.CV.CVC	17	1%
	CVC.CVC.CV	16	1%
Total number of words*		2806	74%

* Total number of target word shapes that occurred at a frequency more than 1% of all target words (n=2,104; 26%). Note: Shaded cells indicate words that contain one or more geminate (n=406; 16%).

Table 5.3 Overall type frequency of target word structure according to syllable number

Data presented in table 5.3 show that disyllabic words are the most commonly used words in KA (52%), followed by trisyllabic (17%) and monosyllabic words (8%). Words containing geminates are highlighted in grey (table 5.3); the accumulative frequency of all words with geminates is 16% of all word shapes.

5.2.2. Token frequency

Token analysis was carried out for word tokens used in KA spontaneous child speech. Figure 5.3 demonstrates token frequency of all groups of KA consonants grouped according to production manner.
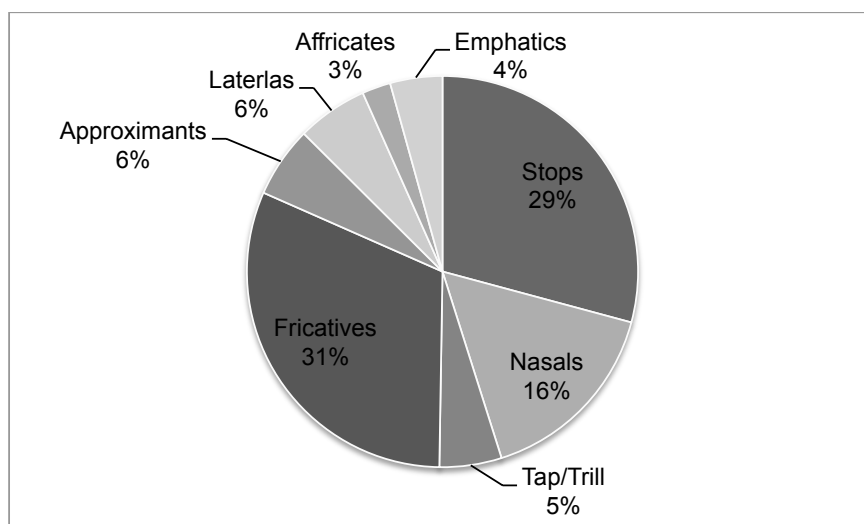
Figure 5.3: The distribution of KA token consonants in target words

Stops and fricatives are the two most frequently targeted consonants in KA child speech, with occurrence frequencies of 28% and 24% respectively, followed by nasals (15%), emphatics (10%), approximants (9%), and laterals (7%). Trill and tap and affricates were the least frequently targeted consonants (5 % and 2% respectively).

The chart in figure 5.4 (below) demonstrates the frequency of occurrence of target consonants that are used by KA speaking children in spontaneous speech in all word position.
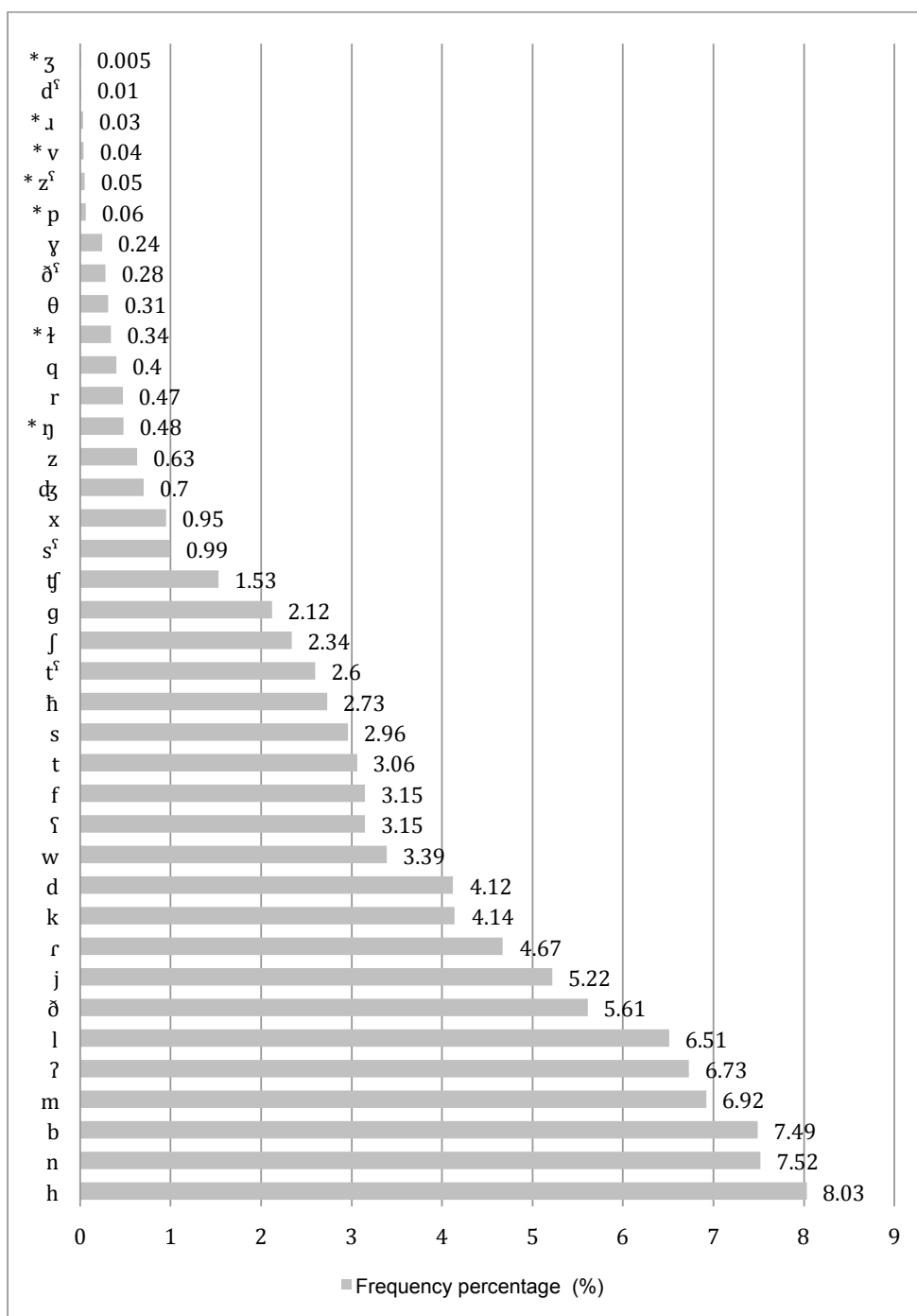
* Marked consonants are considered as non-Arabic, but occur normally in adult speech of KA as a result of phonological assimilation or in intra-dialectal variations.

Figure 5.4: Overall target consonant frequencies in spontaneous speech samples of KA speaking children (Token Frequency)

Figure 5.4 shows that /h/ is the most frequent consonant used in KA spontaneous speech (8.03%), followed by /n/ (7.52%) and /b/ (7.49%). Several

non-Arabic consonants were found to occur among the least frequently used tokens in KA (e.g. /v/, /p/, /ɹ/, /ŋ/); this was evident whether frequency was looked at according to type or token (see section 5.1.7 for discussion).

Word shapes that occurred in more than 1% of total number of words are listed according to occurrence frequency in table 5.4.

Syllables	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
1-syllable	355	264	507	899	866	798	1,085	4,774
2-syllables	675	710	1,177	2,527	2,427	2,297	2,481	12,294
3-syllables	92	66	55	703	657	474	544	2,591
4-syllables	2	2	4	54	38	47	75	222
5-syllables				1		1	3	5
Total	1,124	1,042	1,743	4,184	3,988	3,617	4,188	19,886

Note: Grey shaded cells denote zero value.

Table 5.4: Target word-length occurrence count across age groups

It can be seen in table 5.4 that disyllabic words were most frequently targeted words followed by monosyllabic and trisyllabic words; whereas monosyllabic words predominates the production of children acquiring English at this age (Dodd, 1995; Dyson, 1988; Watson & Scukanec, 1997).

The data presented in table 5.5 shows increase in number of words and length with age. Word shape occurrences were counted and the frequency of each word shape was calculated based on total number of target words. For example, CVV.CV word shape was targeted 3,846 times; this number was then divided by total number of target words (*N*=13,888); and multiplied by 100. That is CVV.CV word shape forms 19% of all target word structures.

Syllable count	Word shape	No. Occurrences	Frequency[£]
1-syllable	CCVVC	329	2%
	CVCC	282	1%
	CCVV	161	1%
2-syllables	CVV.CV	3,846	19%
	CVC.CV	809	4%
	CVC.CVC	762	4%
	CV.CV	760	4%
	CV.CVVC	744	4%
	CV.CVC	679	3%
	CVC.CVVC	580	3%
	CV.C:V	570	3%
	CVV.CVC	569	3%
	CV.CVV	554	3%
	CV.C:VV	460	2%
	CV.C:VVC	355	2%
	CVC.CVV	208	1%
	CCVV.CV	184	1%
	CVVC.CV	175	1%
	CV.C:VC	173	1%
	CVV.CVV	137	1%
	CVC.CVCC	130	1%
3-syllables	CV.CVV.CV	442	2%
	CV.C:VV.CV	410	2%
	CV.CV.CV	183	1%
	CVC.CV.CVVC	146	1%
	CVC.CV.CV	137	1%
	CVC.CVV.CV	103	1%
Total number of words*		13,888	70%

* Total number of target word shapes that occurred in frequency more than 1% of all target words (n=5,999; 30%). Note: Shaded cells indicate words that contain one or more geminate (n=1,968; 10%).

Table 5.5: Overall token frequency of target word structures according to length

As was found token type frequencies presented in table 5.3, frequency analysis (table 5.5) shows that disyllabic words are the most commonly used words in KA (60%), followed by trisyllabic (8%) and monosyllabic words (4%).

Words containing geminates are highlighted in grey (table 5.5); the cumulative frequency of all words with geminates is 10%. Gemination is a phonological feature of Arabic; however, the frequency of geminate occurrence has never been reported for Arabic. All Arabic consonants can be geminated and are contrastive in all dialects of Arabic. In KA, all geminates occur in word-medial contexts. Several studies of gemination that occur in other languages have shown that there is a general agreement that duration plays a major role in

distinguishing singleton and geminate consonants in languages (F. Al-Tamimi, Abu-Abbas, & Tarawnah, 2010; Khattab & J. Al-Tamimi, 2013; Kunnari et al., 2001); in addition to other acoustic and articulatory cues (Hassan, 2002; Khattab, 2007) that contribute to the perceptual saliency of gemination which may result in early acquisition of geminates in KA.

From table 5.5, it can be seen that CVV.CV word shape is the most frequently targeted word structure. Note that 51% of all CVV.CV shapes are the Arabic pronouns /ˈhaː.ðə/ 'this'+masculine and /ˈhaː.ði/ 'this'+feminine which were targeted 1,973 times (out of 3,846 CVV.CV words). The actual frequency of CVV.CV words, excluding 'this' pronoun is 10% (*n*= 1,873); it remains the highest among other target shapes.

The second most frequent target shape is CVC.CV, followed by CVC.CVC. The following examples are selected from the most frequent target words:

CVV.CV	/ˈʔaː.nə/	'me/I'
	/ˈkaː.hi/	'here it is' + feminine
	/ˈha:.ða/	'this'+masculine
CVC.CVC	/ˈʔaz.rag/	'blue'
	/ˈʔaħ. maɾ/	'red'
	/ˈʔaɾ.nab/	'rabbit'
CVC.CV	/ˈʔin.ta/	'you' + masculine
	/ˈwar.də/	'flower'
	/ˈgatˤ.wa/	'cat'

Word structure increase in both variability and complexity with age (see table 5.4). After the age of 2;4 all groups show marked growth in 4-syllable word use. Words longer than 4-syllables were only targeted by children above the age of 2;4.

Data in table 5.6 show great expansion of word structure variability after the age of 2;4. In general, the expansion in word length at 2;4 also coincides with remarkable growth in number of target words (see table 5.2).

Age (year;month)	No. of target words	No. of words containing geminates	No. of different shapes
1;4-1;7	1,125	189	35
1;8-1;11	1,042	58	40
2;0-2;3	1,743	176	51
2;4-2;7	4,184	500	140
2;8-2;11	3,988	557	111
3;0-3;3	3,617	299	149
3;4-3;7	4,188	361	159
Total	19,887	2,140	240*

* The total number of different word shapes that were produced by all age groups collectively.

Table 5.6: Target words shape and geminate occurrence across age groups

From table 5.6, it can be seen that the number of target words increase with age in proportion to increasing word structure variability. The youngest group targeted only 35 different word structures in spontaneous speech, while the oldest group targeted 159 different word structures. The number of geminates targeted did not show similar linear correlation. This variability in word structures was expected in spontaneous speech samples. Out of all target structures, only five structures containing geminates were used frequently. The following examples were extracted from actual data, and are presented in order according to frequency (1 being the most frequent):

(1) CV.Cː V   /ˈjə.mːa/   'mum'
                 /ˈba.tˤːa/   'duck'

(2) CV.Cː VV   /ʔa.ˈɫːaː/   'Allah' (God)
                 /mi.ˈnːiː/   'here'

(3) CV.Cː VV.CV

/ði.ˈbːaː.nə/ 'fly'   / fa.ˈtˤːoː.mə/ 'Fattooma' (name)
/ xa.ˈlːuː.di/ 'Khalloodi' (name) / ħə.ˈmːuː.di/ 'Hammoodi' (name)

(4) CV.Cː VVC

/mi.ˈnːaːk/   'there'   /tɔ.ˈfːaːħ/   'apples'
/da.ˈnːaːj/   'move'+feminine   /ʕa.ˈbːuːd/   'Abbood' (name)

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(5)   CV.C:VC

    /saˈbːaħ/   'bathe'   /ˈxə.rɛʕ/   'scary'

    /saˈkːər/   'close'   /ˈxa.ɫːəsʕ/   'finished'

Note that both CV.C:VV.CV and CV.C:VVC shapes are often used as variants of Arabic names in Kuwait and the Arabian Gulf area. For example, the name /ˈxaː.lid/ is often changed to /xaˈlːuː.di/ or /xaˈlːuːd/ as a nickname often used in child directed speech and casual conversations. The sociolinguistic bases of this common change were never documented in the literature.

5.2.2.1. *Stress patterns of target token words:*

The growth in word shape variability was reflected on target word stress patterns. Table 5.7 illustrates wide variability of stress patterns of target words. Data presented in table 5.7 show clear growth in stress pattern diversity with increasing age. The target words produced by the youngest age group was limited to five stress patterns, whereas the eldest age group targeted eight different stress patterns in complex word shapes. Stress patterns in KA have not been examined in earlier studies, and neither have dialectal variations within KA. Taqi (2009) examined specific phonological variables in Najdi and Ajami variants of KA. However, her investigation did not look at variation in word structure or stress patterns.

Stress pattern	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
Sw	447	545	825	1,594	1,565	1,634	1,620	8,230
wS	228	165	352	933	862	663	861	4,064
wSw	91	62	45	542	629	421	450	2,240
wwS	1	3	3	150	28	52	94	331
wwSw	2	2	4	45	30	42	66	191
wwwS				5	7	3	9	24
Sww		1	7	11		1		20
wSww				4	1	2		7
wwwSw				1		1	2	4
wwwwS							1	1
Total words*	769	778	1,236	3,285	3,122	2,819	3,103	
								15,112

* Excluding monosyllable words. S stands for Strong and w stands for weak syllables.
Grey shaded cells denote zero value.

Table 5.7: Target word stress patterns across age groups

The following examples illustrate the most prominent variants in word structures that were produced by children in the current study:

(3)   a. /smi.ˈʧa/   b. /ˈsim.ʧa/   'fish'
         CCV.**CV**   **CVC**.CV

(4)   a. /ħa.ˈliʤ.ha/   b. /ˈħalʤ.ha/ 'her mouth' + feminine 2nd person
         CV.**CVC**.CV   **CVCC**.CV

In both examples (3) and (4) two different word structures imply the same meaning and are often used in two different dialects of KA. Example (a) in both (3) and (4) are commonly used by Najdi KA speakers, while (b) are frequently used by Ajami KA speakers. The sociolinguistic background of this speculation is beyond the scope of this study; thus in the current study the researchers has adapted the target transcriptions to the parent's dialect to avoid false mismatch between target and actual realisation transcriptions. In other words, the child's target word was matched to a transcription of the mother's realisation of the target word.

5.2.2.2.   Syllable shape frequency in target tokens:

This section shows findings of syllable shape analysis. A variety of word shapes are possible in Arabic. Syllable shapes that were targeted spontaneously by KA speaking children are listed in table 5.8. The grey shaded cells in the table indicate syllable shapes that were not targeted by children in the corresponding age group.

Syllable	Number of occurrences								Frequency[*]
Shape	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total	
CV	1,451	1,376	2,131	4,762	5,020	4,208	5,078	24,026	62.16%
CVC	655	550	857	2,851	2,410	2,594	3,061	12,978	33.57%
CVVC	47	23	36	51	99	115	101	472	1.22%
CVCC	11	0	0	133	52	66	100	362	0.94%
CVV	14	9	43	31	20	73	45	235	0.61%
CCV	15	8	2	41	27	42	63	198	0.51%
CCVC	6	5	9	47	23	46	40	176	0.46%
CCVCC	0	0	0	0	0	3	1	4	0.01%
CVVCC	0	0	0	0	2	1	1	4	0.01%
CCVV	0	0	0	0	0	1	0	1	0.00%

[*] Token Frequency

Table 5.8: Syllable shapes occurrence in KA children spontaneous speech.

The number of syllable shapes targeted by children increased with age alongside syllable complexity. The two dominant types are CV and CVC, they account for 62% and 34% of all syllables in KA respectively. The high number of CV types in this table is due to their occurrence in multisyllabic words. Note that syllables listed in table 5.8 are listed regardless of their word position or stress.

5.2.3. Type versus token frequency

This section will present similarities and differences between type and token frequency analysis. Table 5.9 shows the occurrence frequency of KA consonants in target words produced by all groups of children in the current study, grouped according to production manner. From table 5.9, it can be seen that there is general agreement between those two kinds frequency calculations. Except for stops and fricatives, the frequency of all other less frequently occurring consonants seems to be in agreement. Under the assumption that both type and token frequencies are normally distributed (based on data presented in the current study), then the t-test *(t = 0.824* two tailed). Therefore, the difference between type and token frequency is not significant. This agreement could possibly reflect the child's tendency to select familiar or relatively easy to produce segments (or words containing segments), that are stored in their lexical repertoire (Vihman, 1996, 2013). The differences between type and token frequencies are to be highlighted in the following tables.

	Token Count	Token Frequency	Type count	Type Frequency
Stops	14,116	29%	2,870	31%
Nasals	7,688	16%	1,281	14%
Trill/tap	2,644	5%	645	7%
Fricatives	14,923	31%	2,296	25%
Approximants	2,713	6%	816	9%
Laterals	3,073	6%	816	9%
Affricates	1,162	2%	224	2%
Emphatics	2,076	4%	381	4%
Total	48,395	100%	36,710	100%

Table 5.9: Type and token frequencies of consonants occurring in KA spontaneous child speech.

However, detailed analysis of frequent consonants (Table 5.10) reveals some discrepancy between type and token frequencies. For example, token frequency analysis shows that the voiceless glottal fricative (/h/) is the most frequent consonant followed by the voiced alveolar nasal (/n/) and the voiced bilabial stop (/b/). Type frequency, on the other hand, shows that /l/ is the most frequently used consonants, followed by /n/ and /b/. Comparably, earlier studies of the development of Arabic phonology found that /n/ and /b/ occur in high frequency (e.g. Amayreh and Dyson, 2000; Saleh et al., 2007). The token frequency of /h/ could possibly result from the frequent use of the Arabic pronouns /haːðə/ 'this-masculine' and /haːði/ 'this-feminine' by either the parent or the child during the recording sessions in an attempt to encourage the child to name as many objects or pictures. This again was reflected in the frequency of the voiced dental fricative /ð/ which has token frequency of 5.6% and lower type frequency of 0.5%.

	Frequency		Type frequency	Token frequency
Most Frequent ↑	>5%	Stops:	/b, t, ʔ/	/b, ʔ/
		Nasals:	/m, n/	/m, n/
		Tap/Trill:	/r/	
		Fricative:		/h, ð/
		Approximant:	/j/	/j/
		Lateral:	/l/	/l/
		Affricate:		
		Emphatic:		
	<5%	Stops:	/d, k, g/	/t, d, k, g/
		Nasals:		
		Tap/Trill:		/r/
		Fricative:	/f, s, z, ʃ, x, ħ, ʕ, h/	/f, s, ʃ, ħ, ʕ/
		Approximant:	/w/	/w/
		Lateral:		
		Affricate:	/ʧ/	/ʧ/
		Emphatic:	/tˤ, sˤ/	/tˤ/
↓ **Least frequent**	<1%	Stops:	/p, q/	/p, q/
		Nasals:	/ŋ/	/ŋ/
		Tap/Trill:	/r/	/r/
		Fricative:	/v, θ, ð, ɣ /	/v, θ, z, ʒ , x, ɣ/
		Approximant:	/ɹ/	/ɹ/
		Lateral:	/ɬ/	/ɬ/
		Affricate:	/ʤ/	/ʤ/
		Emphatic:	/ðˤ, dˤ, zˤ/	/ ðˤ, dˤ, sˤ, zˤ/

Table 5.10: Type and token consonant frequency in KA child speech

Both type and token frequency analysis shows that the least frequently used consonants are mostly non-Arabic consonants (e.g. /v, p, ɹ, ŋ/) except for /dˤ/ and /ʒ/. The English velar nasal consonant /ŋ/ was produced by only two children out of 70 samples. The two children (cousins) were recently introduced to the cartoon character King Kong. They produced the word /kiŋ.koŋg/ repeatedly, hence the /ŋ/ was produced 113 times collectively, which had great impact on its frequency rank. However, this consonant was excluded from the production accuracy calculations as it did not meet the criteria of being produced by five children within an age group. Another less frequent KA consonant is the voiced alveolar emphatic stop /dˤ/, which occurs frequently in MSA; however, in the KA dialect it is often realised as [ðˤ] as in the the following examples:

(1) MSA:
     a. /dˤif.dəʕ/   'frog'
     b. /dˤa.ri/   'Dhari' (Arabic name)
(2) KA:

a. [ðˤif.dəʕ]   'frog'
b. [ðˤa.ri]   'Dhari' (Arabic name)

Likewise, the voiced post-alveolar fricative /ʒ/ occurs in dialects of Arabic other than KA, such as Jordanian and Lebanese. The consonant /ʒ/ was observed in the speech of one child in the sample. However, it was produced twice only by the child and therefore did not affect its frequency (less than 0.01%). The KA equivalent of the /ʒ/ fricative is the affricate /ʤ/. One possible explanation is that a member of the child's family speaks other dialects of Arabic (extended family), from which the child acquired the sound.

Consonant occurrence frequency was also calculated for each word position. Table 5.11 presents type and token frequencies of target consonant occurrence in word-initial –medial, and -final positions and the overall production accuracy percentages for each consonantal group (figures 5.5, 5.6 and 5.7).

Consonant Frequency	Word Initial			Word Medial			Word Final			Total Words
	Type	Token	PCC	Type	Token	PCC	Type	Token	PCC	
Stops	43%	38%	88%	24%	21%	85%	28%	34%	86%	
Nasals	10%	12%	90%	14%	18%	87%	20%	20%	87%	
Trill/tap	2%	1%	51%	10%	8%	55%	10%	12%	55%	
Fricatives	27%	33%	70%	27%	31%	60%	18%	20%	79%	
Laterals	2%	4%	89%	12%	8%	88%	9%	9%	86%	
Approximants	10%	6%	83%	6%	6%	85%	6%	1%	92%	
Affricates	2%	4%	46%	2%	1%	59%	4%	3%	75%	
Emphatics	4%	3%	40%	5%	6%	52%	4%	3%	56%	
Total Types	2,806 (35)[*]			4,434 (39)[*]			1,472 (35)[*]			8,712
Total Tokens	19,803			23,932			4,656			48,391

[*] The number of different consonant types

Table 5.11: The frequency of target consonant occurrence in word-initial, word-medial and word-final positions.

Table 5.11 shows relative agreement between type and token frequencies in all word positions. For instance, stops were found to be produced in word initial position with type frequency of 43% and token frequency of 38%; followed by nasals and fricatives. The frequency of consonantal groups is calculated in all word positions (table 5.10). Figures 5.5, 5.6 and 5.7 show the occurrence frequency of KA consonants in all word positions.
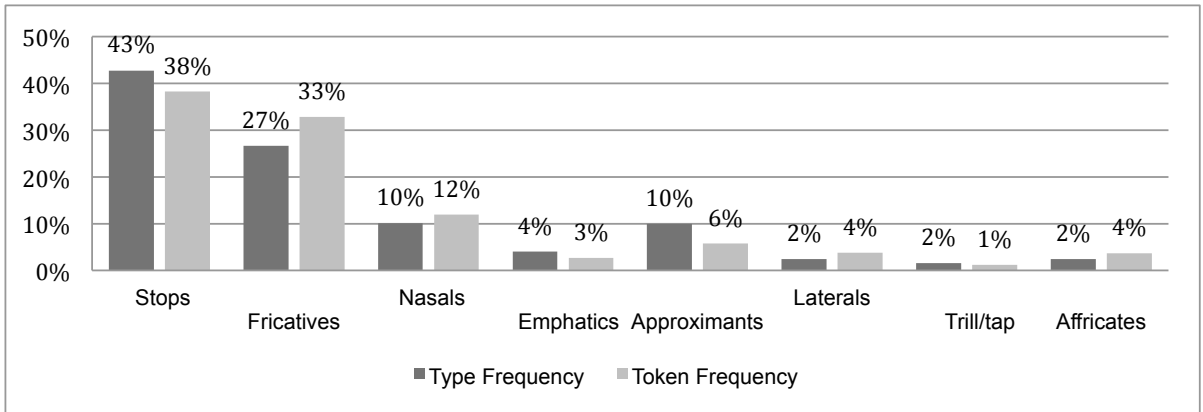
Figure 5.5: Word-Initial Consonant Occurrence Frequency
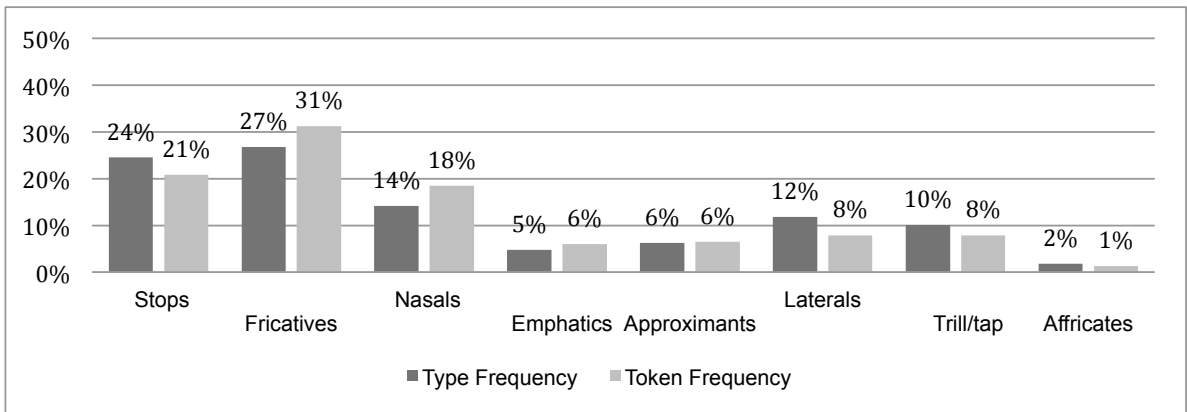
Figure 5.6: Word-Medial Consonant Occurrence Frequency
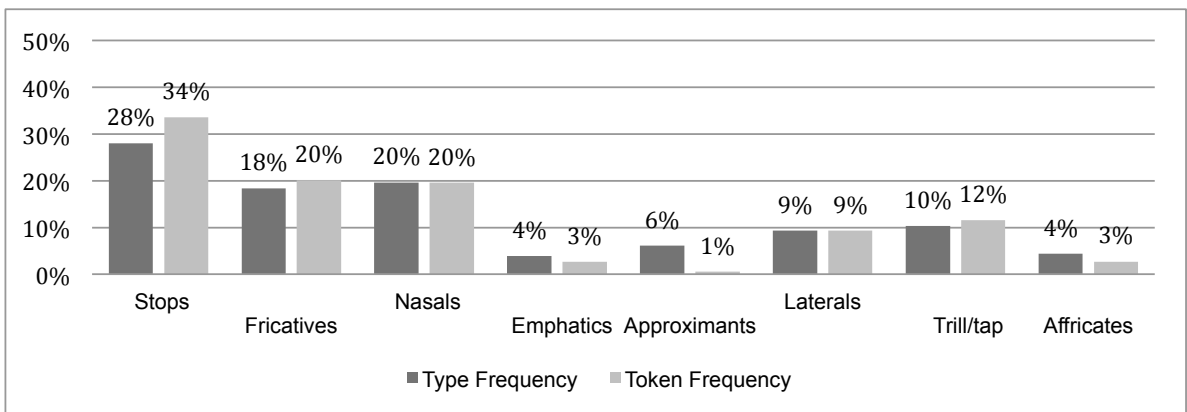
Figure 5.7: Word-Final Consonant Occurrence Frequency

There is a general agreement between type and token occurrence frequencies in all word positions. Where stops seem to be most frequent at word edges (initial and final); liquids seem to be more frequently targeted in medial and final than in initial position; fricatives are targeted more frequently in initial and medial than final position.

Statistical measurements were not obtained here for two reasons: (1) the normal distribution of KA consonants in adult speech is unknown; (2) and the assumption of normal distribution could not be based on data collected for the current study because of the limited number of participitants in the current study which may not be representitive of all KA consonants in adult and child speech.

Comparing the results of token and type frequency of word structures of target words reveals a child preference to use of certain word structures.
The most frequently targetted shape is CVC.CVC (type frequency 6%); where this word shape occurs less frequently in token frequency analysis (4%). Likewise, token frequency analysis showed that CVV.CV word structure occurs most frequently (19%); but it was used less frequently as its type frequency is considered (5%) (see tables 5.5 and 5.3). The observed difference between type and token could possibly mean that KA speaking children show preference to some word shapes which they tend to use more frequently.

This preference for particular word stuctures was reflected in the stress patterns used by KA speaking children. Table 5.12 shows type and token frequency of different stress patterns. Stressed syllables are marked 'S' and weak syllables are marked 'w'. Type frequency analysis of stress patterns shows equal occurrence of wS and Sw patterns; where as token frequency showed higher tendency to use the Sw pattern. Other less frequently used patterns were found to occur in similar order in both type and token frequency (e.g. wSw, wwS, wwSw).

Type Stress Pattern	Count	Frequency	Token Stress Pattern	Count	Frequency
wS	770	31%	Sw	8,230	54%
Sw	762	31%	wS	4,064	27%
wSw	697	28%	wSw	2,240	15%
wwS	144	6%	wwS	331	2%
wwSw	88	4%	wwSw	191	1%
wwwS	13	1%	wwwS	24	0%
Sww	8	0%	Sww	20	0%
wwwSw	4	0%	wSww	7	0%
wSww	3	0%	wwwSw	4	0%
wwwwS	1	0%	wwwwS	1	0%
Total*	2,490			15,112	

*Excluding monosyllabic words.

Table 5.12: Type and token frequencies of target word stress patterns in KA.

The difference between type and token frequency can possibly reflect the child's preference for certain word structures. For example, if a child was tested using a word list that reflects the occurrence of certain structure in the language, the child preference may not be appreciated which result in higher error rate. Whereas if those tendencies were taken into account, the assessment may show rather faithful phonological profile of the child.

The child's preference for certain word structures could possibly reflect ease of production, where the child chooses lexical items with less complex structures or may be influenced by the occurrence frequently in child directed speech. For instance, there was evident tendency to target words containing geminates less frequently in tokens than in types. Type frequency of words containing geminates was 16%, where as token frequency was only 10%; however, conclusions may not be made within the scope of the current study, thus further detailed analysis is needed.

The following section will show analysis results of consonant production accuracy and error patterns in all word positions.

5.3. Consonant acquisition in KA

The section presents the production accuracy of each consonant. The first part reports consonant production accuracy in relation to the frequency of its occurrence. The second part reports consonant production accuracy of each age group.

5.3.1 Overall production accuracy across age groups

Consonants are listed in table 5.13 below according to the frequency of their occurrence in spontaneous KA child speech. Consonants on top of the table were produced more frequently whilst the ones at the bottom were least frequent.

The cells are colour coded to represent different ages of acquisition for each consonant. The black cells represent mastery age of acquisition (i.e. consonants that were produced accurately in more than 90% of total number of occurrences); the dark grey cells represent acquisition age (i.e. consonants that were produced accurately in more than 75% of total number of occurrences); the light grey cells represent customary age (i.e. consonants that were produced accurately in more than 50% of total number of occurrences); the white cells represent consonants that were not acquired (i.e. consonants that were produced accurately in less than 50% of total number of occurrences); and the white shaded cells with starred values represent consonants that did not meet our inclusion criteria where each consonant has to occur in target words attempted at least once by five out of ten different children in a group.

All consonants listed in table 5.13 belong to the Arabic consonant inventory except for a few non-Arabic consonants that are often used by children in borrowed English words or character names (e.g. /p, v/). Additionally, other consonants such as pharyngeal /ɬ/ and the emphatic /zˤ/ are specific to Arabic dialect in the Arabian Peninsula and were not listed as Arabic consonants in studies of the development of Jordanian and Egyptian dialects of Arabic.

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Rank	C	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Overall PCC (%)
1.	/h/	36	51	59	78	76	90	89	76
2.	/n/	79	81	86	90	78	87	92	86
3.	/b/	83	84	85	81	83	94	94	87
4.	/m/	87	85	78	88	91	92	93	89
5.	/ʔ/	91	90	92	92	92	94	94	93
6.	/l/	69	69	63	87	86	90	95	87
7.	/ð/	1	5	24	38	46	63	48	41
8.	/j/	44	77	82	78	80	87	89	79
9.	/ɾ/	4	10	19	47	46	76	63	53
10.	/k/	71	67	90	86	96	96	98	87
11.	/d/	64	60	68	79	78	89	95	80
12.	/w/	79	71	81	92	87	94	98	90
13.	/f/	8	42	43	74	75	86	91	75
14.	/ç/	28	9	39	48	58	70	85	61
15.	/t/	67	84	70	81	79	88	93	84
16.	/s/	32	56	79	81	74	80	93	80
17.	/ħ/	30	48	57	65	72	76	89	72
18.	/tˤ/	3	11	7	33	31	81	84	46
19.	/ʃ/	54	52	45	46	34	83	82	61
20.	/g/	29	58	44	63	73	79	94	71
21.	/ʧ/	5 *	11 *	41 *	56	45	78	82	58
22.	/sˤ/	0 *	0 *	50 *	55	24	57	76	52
23.	/x/	27 *	60 *	26	52	65	69	88	66
24.	/dʒ/	0 *	1 *	33 *	54	16	58	80	39
25.	/z/	0 *	38 *	39	58	53	81	83	66
26.	/ŋ/	0 *	92 *	0 *	60 *	100 *	70 *	100 *	76
27.	/r/	0 *	0 *	25	19	81	66	78	58
28.	/q/	0 *	100 *	0 *	49	14	44	59	42
29.	/ɬ/	0 *	0 *	0 *	39 *	42	74	90	52
30.	/θ/	0 *	0 *	33 *	21	37	63	44	46
31.	/ðˤ/	0 *	0 *	0 *	70 *	58	79	59	67
32.	/ɣ/	0 *	25 *	0 *	30	17	48	70	43
33.	/p/	0 *	50 *	100 *	50 *	67 *	100 *	93	85
34.	/zˤ/	0 *	0 *	0 *	86 *	14 *	67	75 *	59
35.	/v/	100 *	0 *	0 *	60 *	0 *	0 *	0 *	71
36.	/dˤ/	0 *	0 *	0 *	0 *	0 *	100 *	25	29
37.	/ʒ/	50 *	0 *	0 *	0 *	0 *	0 *	0 *	50
	Total	3,054	2,777	4,133	11,408	10,573	10,326	54,509	

	Key:	* Did not match criteria	Not acquired <50%	Customary production 50%-74%	Acquisition production 75%-89%	Mastery production >90%			

*Consonants that were not attempted at least once by five out of ten different children in a group.

Table 5.13: Overall production accuracy across age groups: percentage of consonant correct (PCC %)

Several consonants occur in KA speech but are not considered standard in MSA, such as /ɬ/, /g/ and /ʧ/. The voiced lateral alveolar approximant /l/ and pharyngeal /ɬ/ are distinctive in KA. For example, the KA word /xaː.li/ means 'empty' whereas the same sequence with the pharyngeal /xaː.ɬi/, it means 'my uncle'. Similarly, the voiceless affricate /ʧ/ is often used in KA as a realisation of /k/ in MSA (KA allophony rules are discussed in section 3.5 of Chapter 3), as shown in the following examples:

(1) MSA
      a. /kalb/   'dog'
      b. /kiːs/   'carrier bag'
(2) KA
      a. [ʧalb]   'dog'
      b. [ʧiːs]   'carrier bag'

From table 5.13, it can be seen that some consonants that were used more frequently are acquired earlier than consonants that occur less frequently, however, there were no apparent linear correlations between frequency and age of acquisition. For example, the alveolar stop /t/ was targeted less frequently compared to the alveolar fricative /ð/, however, the former was produced more accurately at an earlier age. Fricatives are more complex consonants than stops. The production of fricatives requires precise motoric control over the vocal apparatus, compared to the production of stops. Based on articulation complexity, one may expect that stops are attempted more frequently and produced more accurately than fricatives. Contrary to expectations, it was found that children targeted /ð/ more frequently than /t/. However, looking at ages of acquisition, less complex consonant /t/ was produced more accurately at an earlier age than /ð/. Therefore, one may argue that the child's phonological acquisition is rather multifactorial, as it can be influenced by the sound complexity as well as frequency of occurrence.

The following subsections present findings of the production accuracy analysis. The consonants are presented in groups based on production manner. Findings are reported for each group of consonants in colour-coded tables followed by graphs to demonstrate developmental progression in relation to age. A linear regression line is added to the graphs to illustrate developmental progress across age groups.

5.3.2 The acquisition of KA stops

Table 5.14 shows the results obtained from the production accuracy analysis of all stops produced spontaneously by KA speaking children.

Conso-nants	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7
/p/	0 *	50 *	100 *	50 *	67 *	100 *	93
/b/	83	84	85	81	83	94	94
/t/	67	84	70	81	79	88	93
/d/	64	60	68	79	78	89	95
/k/	71	67	90	86	96	96	98
/g/	29	58	44	63	73	79	94
/q/	0 *	100 *	0 *	49	14	44	59
/ʔ/	91	90	92	92	92	94	94
Key:	* Did not match criteria	Not acquired <50%	Customary production 50%-74%	Acquisition production 75%-89%	Mastery production >90%		

Table 5.14: Percentage of stop consonants production accuracy (PCC %)

The early acquisition of the glottal stop /ʔ/ in KA is expected as it is often used in syllable onset, as onset-less syllables are prohibited in KA; this explains why it was found to be the second most frequently produced stop after the bilabial stop /b/. The acquisition of the voiceless velar stop /k/ was rather early compared to the bilabial /b/ despite the higher frequency of /b/ occurrence (see figures 5.2 and 5.4 for type and token frequencies).

It is apparent from table 5.14 that all stops were mastered by the age of 3;4-3;7 except /q/. The uvular stop /q/ was not produced by children under the age of 2;4. This late appearance of /q/ may reflect its low occurrence frequency in KA. Although it occurs frequently in MSA, it is rarely used in KA casual speech. In KA /q/ is often realised as /g/ as demonstrated in the following examples:

 (1) MSA
    a. /qaːl/   'he said'
    b. /qaː.ma/ 'he stood up'
    c. /qalb/   'heart'
 (2) KA
    a. /gaːl/   'he said'
    b. /gaːm/   'he stood up'
    c. /galb/   'heart'

Note that, in KA, the word c. /qalb/ often occur in both forms in (1) and (2). The former realisation is often used to describe the 'heart shape' or 'necklace' where as the latter is used to represent a 'heart'. Because of lack of documented literature, this distinction cannot be strictly applied to KA.

The following graphs illustrate the developmental progression in the production accuracy of KA stops across age-groups. Each graph demonstrates pairs of voiced and voiceless consonants.
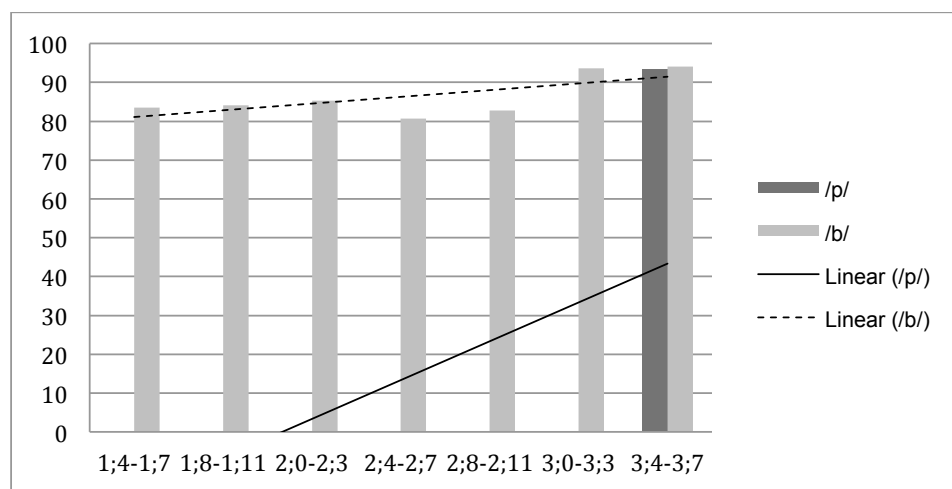
Figure 5.8: The acquisition of /p/ and /b/ across age groups

Figure 5.8 shows that the bilabial voiced stop /b/ accuracy showed steady increase in production accuracy. The English /p/ was mastered by the oldest age group. However, it was produced by less than five out of ten children in the 3;4-3;7 age group, and was not considered as acquired based on the acquisition criteria used in the current study.
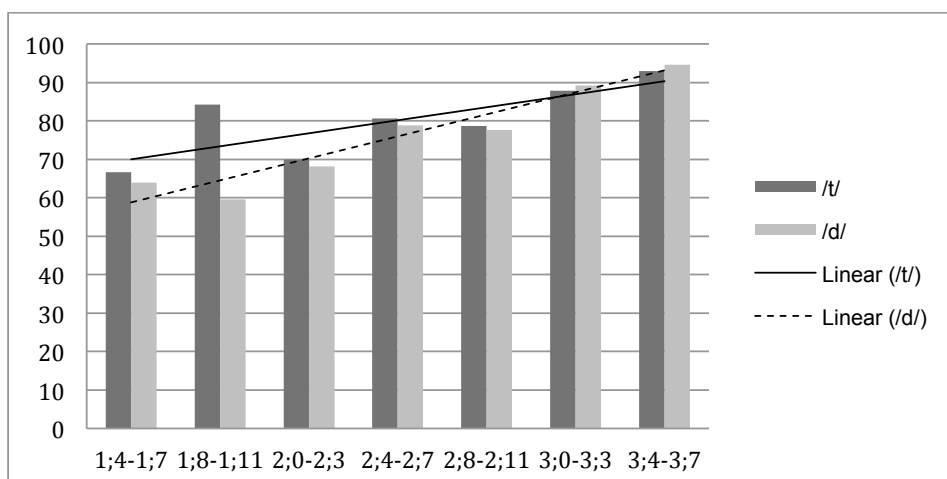
Figure 5.9: The acquisition of /t/ and /d/ across age groups

Both voiced and voiceless alveolar stops follow similar developmental patterns; however, neither was produced with 90% accuracy until ages 3;4-3;7.
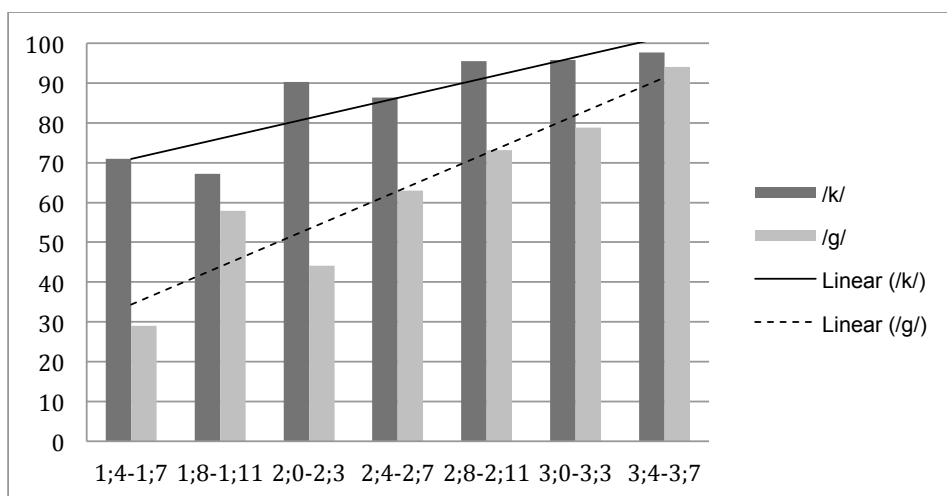
Figure 5.10: The acquisition of /k/ and /g/ across age groups

Voiceless /k/ was mastered before its voiced counterpart /g/. The former was mastered as early as 2;0-2;3, while the latter was not up to the age of 3;4-3;7. The apparent discrepancy between the production accuracy in voiced and voiceless pairs was never reported in earlier studies of Arabic phonological development.

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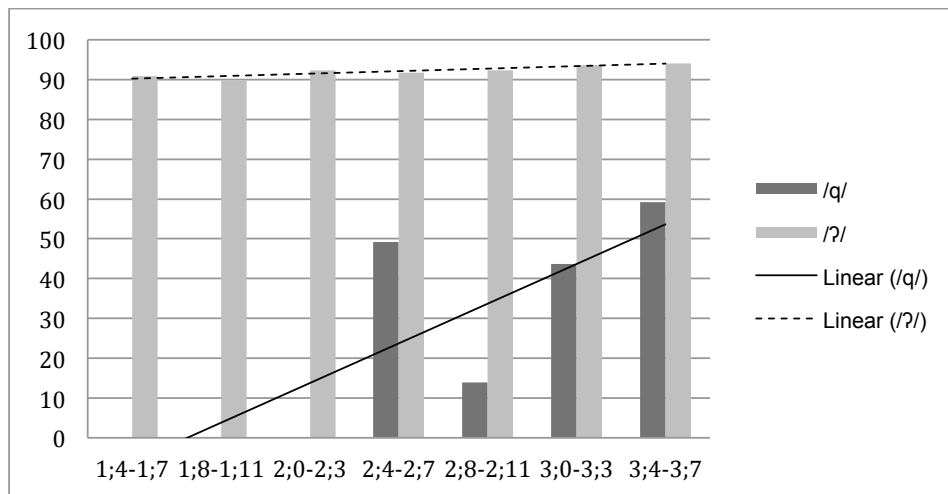
Figure 5.11: The acquisition of /q/ and /ʔ/ across age groups.

The voiceless glottal stop was mastered by all age-groups. The voiced uvular stop /q/ did not appear in the speech of children younger than 2;4-2;7. Similar findings were reported by normative studies of Arabic phonological development (e.g., Amayreh and Dyson, 1998; Saleh et al, 2007).

5.3.3 The acquisition of KA nasals

Table 5.15 shows the results obtained from the production accuracy analysis of all nasal consonants produced spontaneously by KA speaking children.

Cons-onant	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7
/m/	87	85	78	88	91	92	93
/n/	79	81	86	90	78	87	92
/ŋ/	0 *	92 *	0 *	60 *	100 *	70 *	100 *
Key:	* Did not match criteria	Not acquired <50%	Customary production 50%-74%	Acquisition production 75%-89%	Mastery production >90%		

Table 5.15: Percentage of nasal consonants production accuracy (PCC %)

From table 5.15, it can be seen that both bilabial and alveolar nasal consonants were mastered by the age of 3;4-3;7. The bilabial nasal /m/ was mastered earlier than the alveolar nasal /n/. The 2;4-2;7 group produced /n/ accurately in 90% of occurrences, but it is produced less accurately by the following two age bands. The fluctuation in /n/ production accuracy development could possibly

reflect individual variability in word choice and prosodic context, or individual differences in children's sound preference.

The velar nasal /ŋ/ was excluded from the accuracy analysis as it has been produced mostly by two boys out of all 70 children in the sample.
The graph below illustrates the developmental progression in the production accuracy of KA nasals across age groups.
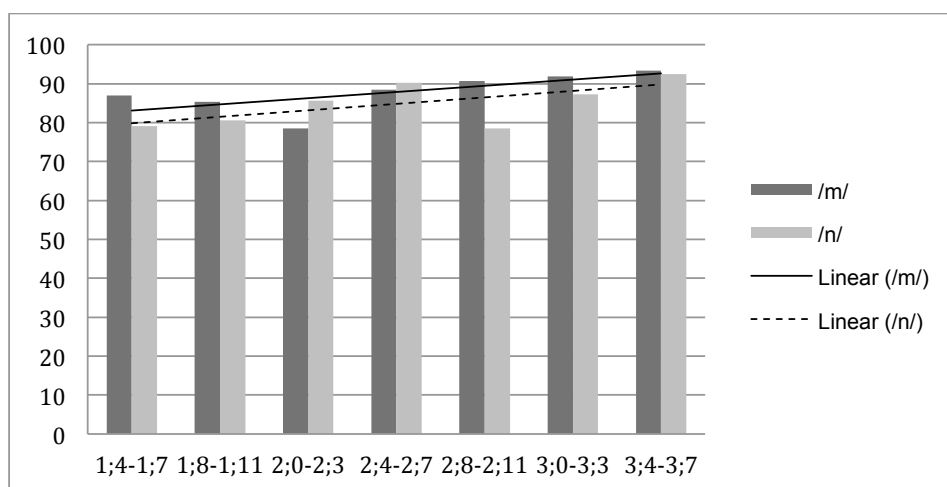
Figure 5.12: The acquisition of /m/ and /n/ across age groups.

The graph in figure 5.12 above shows steady increase in production accuracy of the nasal consonants /m/ and /n/. The progression trend line is relatively flat which indicates early acquisition of nasals despite the fact that both were not mastered (>90%) until 2;8-2;11.

5.3.4 The acquisition of KA tap and trill

Table 5.16 shows the results obtained from the production accuracy analysis of tap and trill consonants produced spontaneously by KA speaking children.

Conso-nant	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7
/r/	0 *	0 *	25	19	81	66	78
/r/	4	10	19	47	46	76	63
Key:	* Did not match criteria	Not acquired <50%	Customary production 50%-74%	Acquisition production 75%-89%	Mastery production >90%		

Table 5.16: Percentage of taps and trills production accuracy (PCC %)

From the table above, it can be seen that neither tap nor trill was mastered by the age of 3;7. Note that trills in KA have a geminate status given their contrast with taps. Geminates are believed to have prominent auditory properties (Lahiri & Hankamer, 1988) and are likely to be accurately perceived. However, its late acquisition is expected due to the higher complexity of trill production compared to tap (Ball, Müller, & Munro, 2001; M. Rose, 2010). The graph below illustrates the developmental progression in the production accuracy of KA tap and trill across age groups.
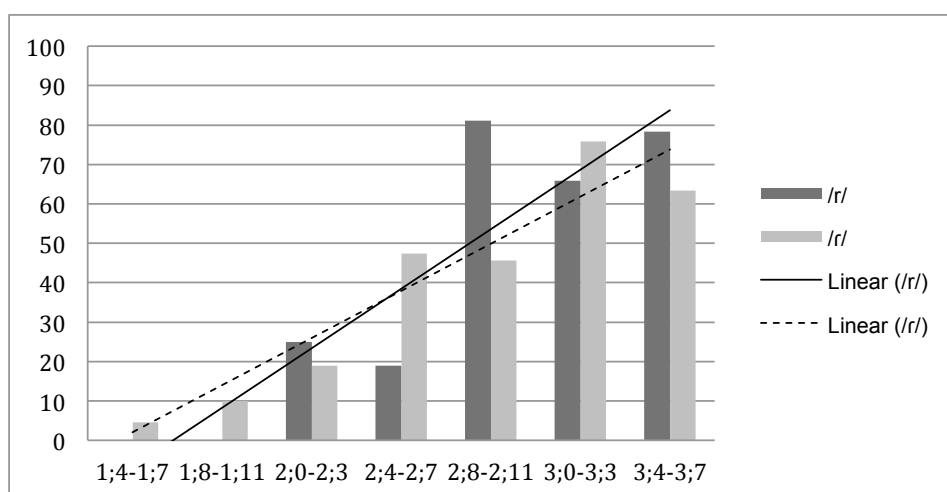
Figure 5.13: The acquisition of /r/ and /r/ across age groups

Both tap and trill show notable increase production accuracy across age bands. However, none of which was mastered up to the age of 3;7.

5.3.5 The acquisition of KA fricatives

Table 5.17 shows the results obtained from the production accuracy analysis of all fricative consonants produced spontaneously by KA speaking children.

Cons-onant	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7
/f/	8	42	43	74	75	86	91
/v/	100 *	0 *	0 *	60 *	0 *	0 *	0 *
/θ/	0 *	0 *	33 *	21	37	63	44
/ð/	1	5	24	38	46	63	48
/s/	32	56	79	81	74	80	93
/z/	0 *	38 *	39	58	53	81	83
/ʃ/	54	52	45	46	34	83	82
/ʒ/	50 *	0 *	0 *	0 *	0 *	0 *	0 *
/x/	27 *	60 *	26	52	65	69	88
/ɣ/	0 *	25 *	0 *	30	17	48	70
/ħ/	30	48	57	65	72	76	89
/ʕ/	28	9	39	48	58	70	85
/h/	36	51	59	78	76	90	89
Key:	* Did not match criteria	Not acquired <50%	Customary production 50%-74%	Acquisition production 75%-89%	Mastery production >90%		

Table 5.17: Percentage of fricatives production accuracy (PCC %).

Table 5.17 shows that only two fricatives /f/ and /s/ were mastered (>90%) by the oldest group 3;4-4;7. Other fricatives, such as /z/, /ʃ/ and /h/ were acquired (>75%) by 3;0-3;3. Note that three fricatives (/θ/, /x/, /ɣ/) did not occur in the speech of children before 2;4. However, despite the late appearance of those three fricatives, /ɣ/ production accuracy reached a maximum of 70% (customary production) by 3;4-3;7; whereas /θ/ and /ð/ were not acquired up to the age of 3;7.

The graphs below illustrate the developmental progression in the production accuracy of KA fricatives across age groups.
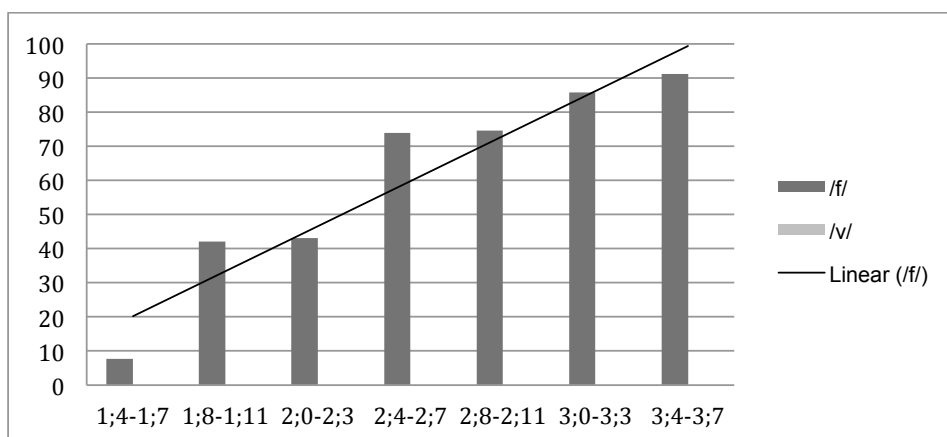
Figure 5.14: The acquisition of /f/ and /v/ across age groups.

The voiceless labiodental fricative /f/ shows positive trend in its production accuracy in correlation with age. (figure 5.14). The /v/ did not fulfil the inclusion criteria as it was not produced by more than five children in any age group.
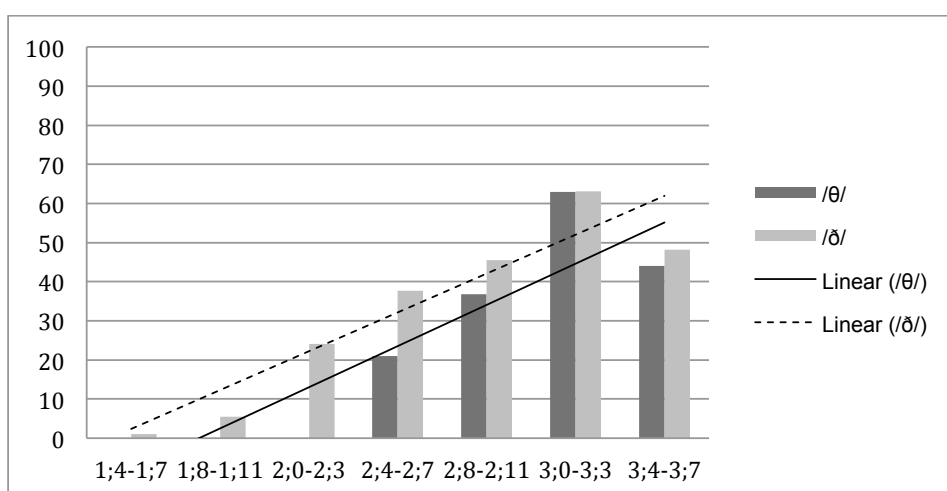
Figure 5.15: The acquisition of /θ/ and /ð/ across age groups.

Both dental fricatives /θ/ and /ð/ show positive production accuracy trend with age (figure 5.15), however, none of which is mastered by the eldest age group (3;4-3;7).
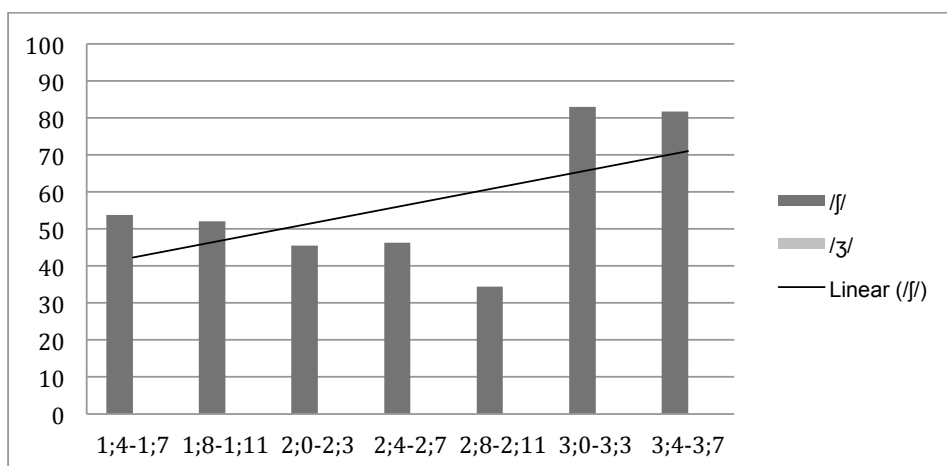
Figure 5.16: The acquisition of /ʃ/ and /ʒ/ across age groups.

The voiceless postalveolar fricative /ʃ/ shows positive trend in its production accuracy in correlation with age (figure 5.16). Children above the age of 3;0 produced /ʃ/ most accurately compared to younger groups. The /ʒ/ did not fulfil the inclusion criteria as it was produced by one child only in the youngest age group.
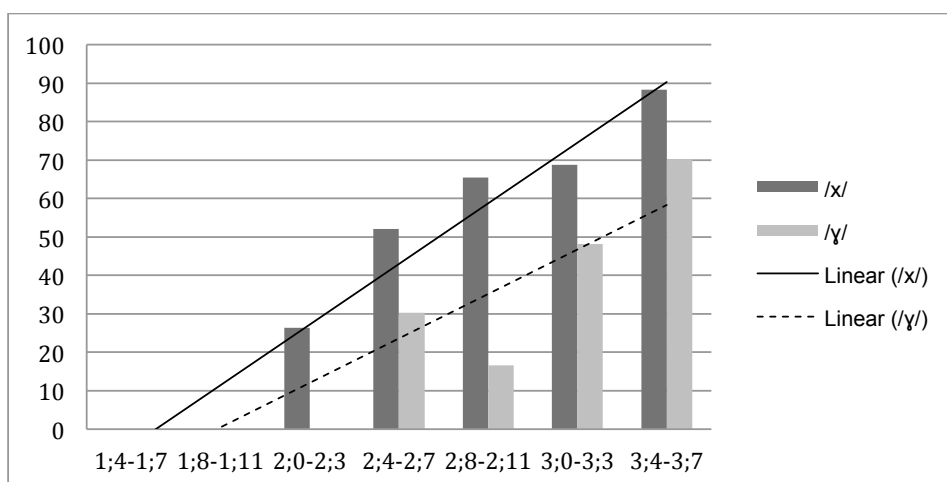
Figure 5.17: The acquisition of /x/ and /ɣ/ across age groups.

Both velar fricatives /x/ and /ɣ/ shows positive trend in production accuracy in correlation with age (figure 5.17); however, none was mastered by the eldest age group (3;4-3;7).
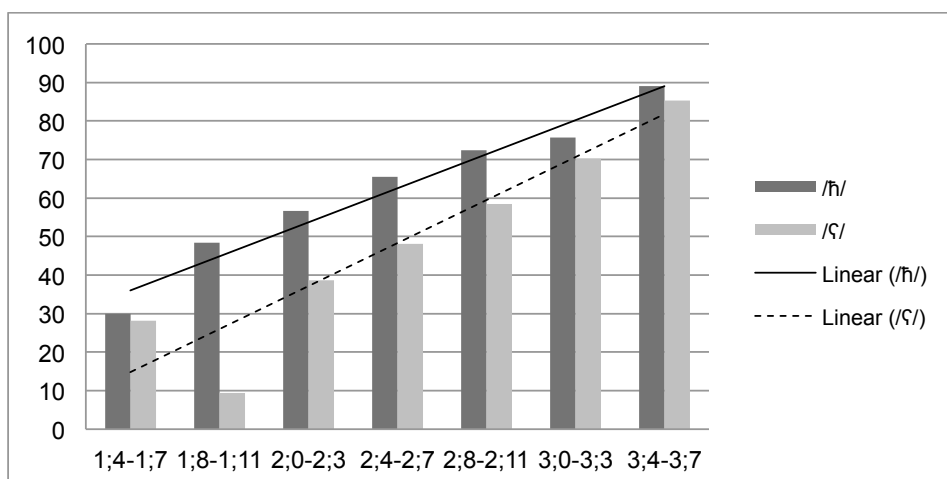
Figure 5.18: The acquisition of /ħ/ and /ʕ/ across age groups.

Pharyngeal fricatives /ħ/ and /ʕ/ show positive production accuracy trend in correlation with age (figure 5.18); however, none was mastered by the eldest age group (3;4-3;7).
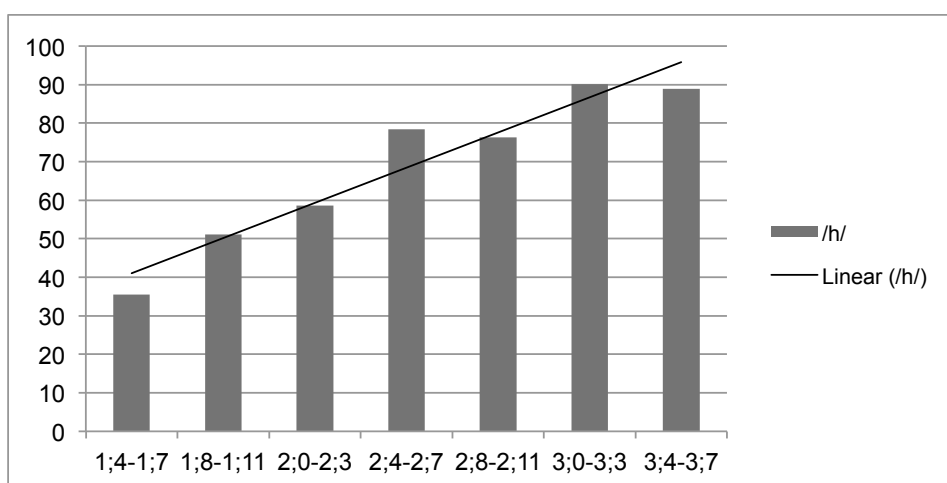
Figure 5.19: The acquisition of /h/ across age groups.

The voiceless glottal fricative /h/, the most frequently used consonant in KA child's speech, shows positive production accuracy trend increasing with age (figure 5.19).

5.3.6 The acquisition of KA approximants and lateral approximants

Table 5.18 shows the results obtained from the production accuracy analysis of all approximants and lateral approximants produced spontaneously by KA speaking children.

Cons-onant	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7
/w/	79	71	81	92	87	94	98
/l/	69	69	63	87	86	90	95
/ɬ/	0 *	0 *	0 *	0 *	42	74	90
/j/	44	77	82	78	80	87	89
Key:	* Did not match criteria	Not acquired <50%	Customary age 50%-74%	Acquisition age 75%-89%	Mastery age >90%		

Table 5.18: Percentage of approximants and lateral approximants production accuracy (PCC %)

The graphs below illustrate the developmental progression in the production accuracy of KA approximants and lateral approximants across age groups.
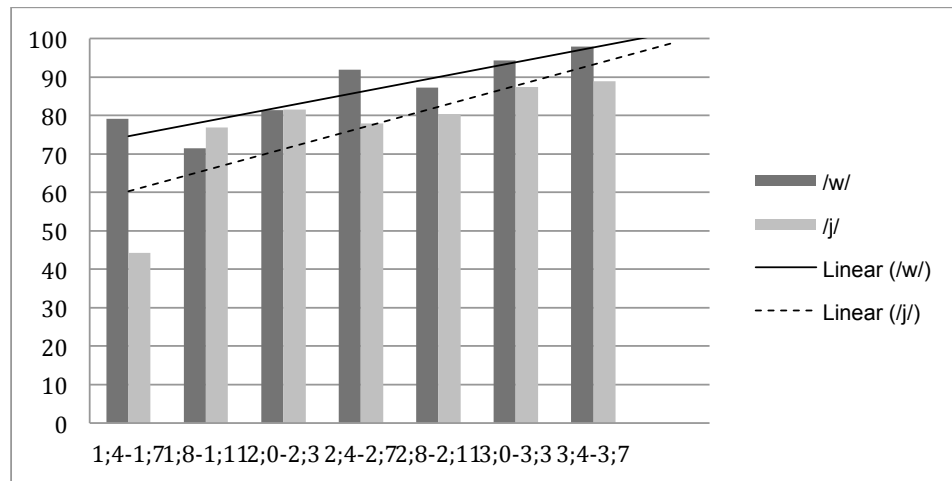
Figure 5.20: The acquisition of /j/ and /w/ across age groups

The production accuracy of both approximants /w/ and /j/ show a steady trend increasing in accuracy with age. All three years old children produced /w/ and /j/ accurately at least 90% of the time.
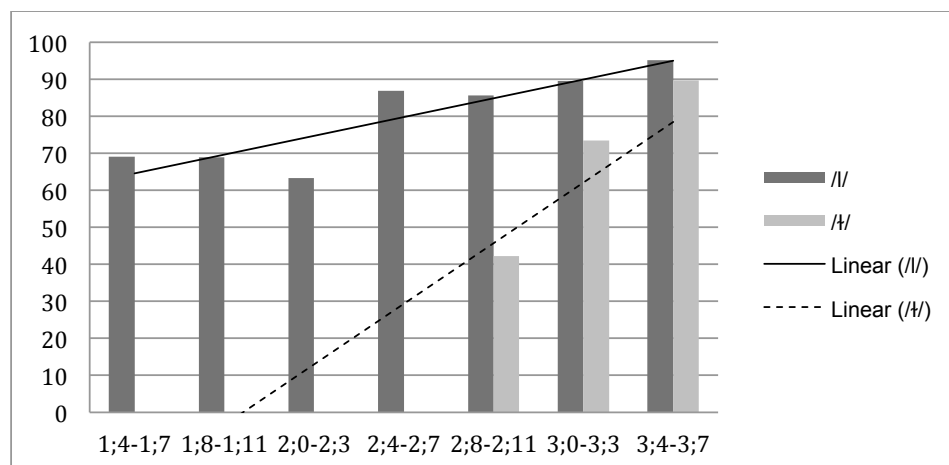
Figure 5.21: The acquisition of /l/ and /ɬ/ across age groups.

The production accuracy of the alveolar lateral approximant/l/ shows a positive trend increasing with age (figure 5.21). The /l/ occurred early in spontaneous speech of KA speaking children, whereas the pharyngeal /ɬ/ was not produced by children under the age of 2;8. The reason behind its late appearance could possibly be due to the articulatory complexity associated with the secondary pharyngealization that occurs often in KA adult's speech (e.g. /bʊ.tˤə.ɬ/ 'bottle').

5.3.7 The acquisition of KA affricates

Table 5.19 shows the results obtained from the production accuracy analysis of all affricates produced spontaneously by KA speaking children.

Cons-onant	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7
/ʧ/	0 *	0 *	0 *	56	45	78	82
/ʤ/	0 *	1	0 *	54	16	58	80
Key:	* Did not match criteria	Not acquired <50%	Customary age 50%-74%	Acquisition age 75%-89%	Mastery age >90%		

Table 5.19: Percentage of affricates production accuracy (PCC %)

Findings presented in table 5.19 show that neither /ʧ/ and /ʤ/ affricates occurred in the speech of children under the age of 2;4. The 2;8-2;11 group showed the least accurate production of affricates compared to all other groups. This fluctuation is inevitable in spontaneous speech sampling, where the child could have produced more or less complex word structures that may influence the production accuracy. In depth analysis of consonant occurrence in relation to word position could provide better explanation to such findings (see section 5.4.6).

The graph below illustrates the developmental progression in the production accuracy of KA affricates across age groups.
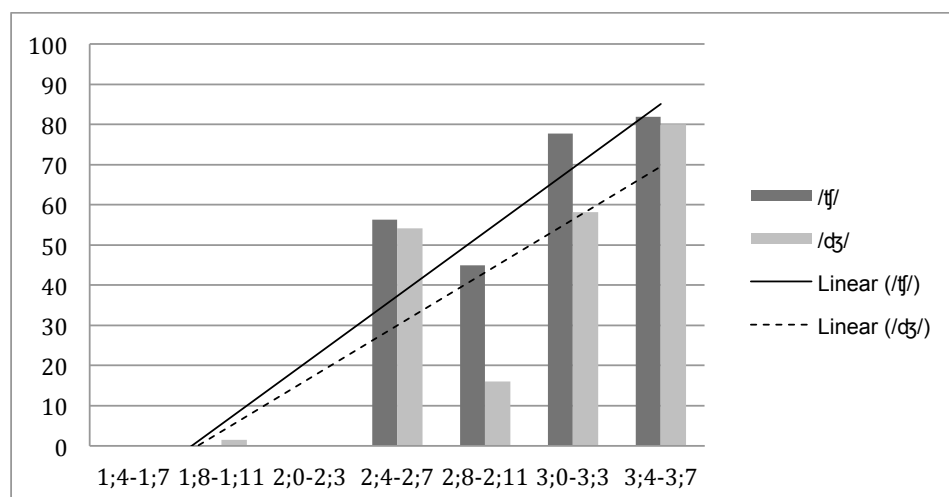
Figure 5.22: The acquisition of /ʧ/ and /ʤ/ across age groups.

Both affricates /ʧ/ and /ʤ/ show positive trend in production accuracy in correlation with age (figure 5.22); however, none of was mastered even by the eldest age group (3;4-3;7).

5.3.8 The acquisition of KA emphatics

Table 5.20 shows the results obtained from the production accuracy analysis of all emphatic consonants produced spontaneously by KA speaking children.

Cons-onant	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7
/ðˤ/	0 *	0 *	0 *	0 *	58	79	59
/tˤ/	3	11	7	33	31	81	84
/dˤ/	0 *	0 *	0 *	0 *	0 *	0 *	25
/sˤ/	0 *	0 *	0 *	55	24	57	76
/zˤ/	0 *	0 *	0 *	0 *	0 *	67	0 *
Key:	* Did not match criteria	Not acquired <50%	Customary age 50%-74%	Acquisition age 75%-89%	Mastery age >90%		

Table 5.20: Percentage of emphatics production accuracy (PCC %)

None of the emphatic consonants is mastered by age 3;7. Out of all five emphatics, /dˤ/ is the latest occurring and least accurately produced emphatic and it only appears in the speech of the eldest group. On the other hand, although /tˤ/ appeared early its accuracy only reached a maximum of 80% at the age of 3;0-3;3.

The graph in figure 5.23 below illustrates the developmental progression in the production accuracy of KA emphatics across age groups.
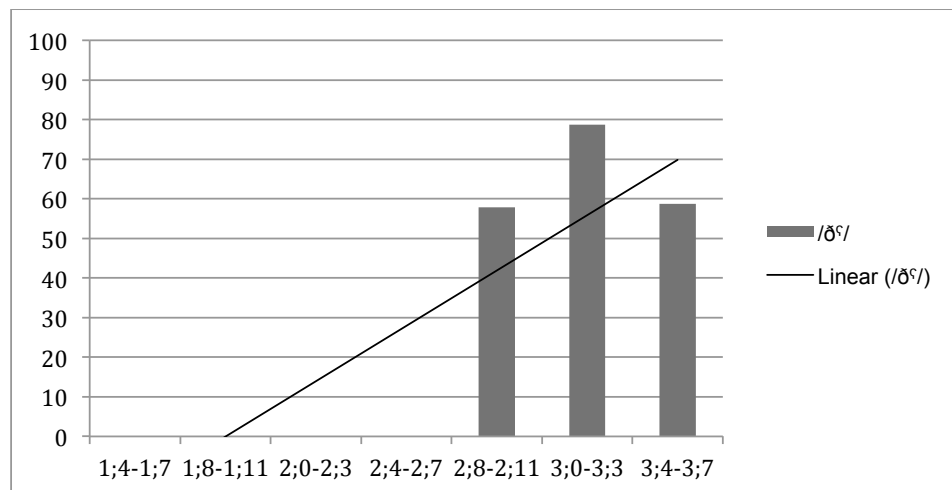
Figure 5.23: The acquisition of /ðˤ/ across age groups.

Despite the late appearance of the /ðˤ/ in spontaneous speech, its production accuracy of /ðˤ/ shows positive trend increasing with age (figure 5.24).
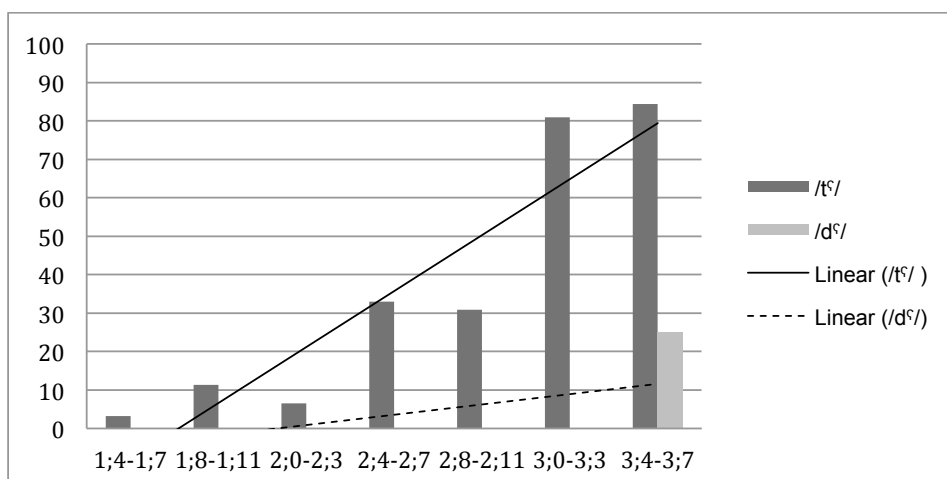
Figure 5.24: The acquisition of /tˤ/ and /dˤ/ across age groups.

The production accuracy of voiceless emphatic /tˤ/ shows positive trend increasing with age compared with its voiced counterpart /dˤ/ (figure 5.24).
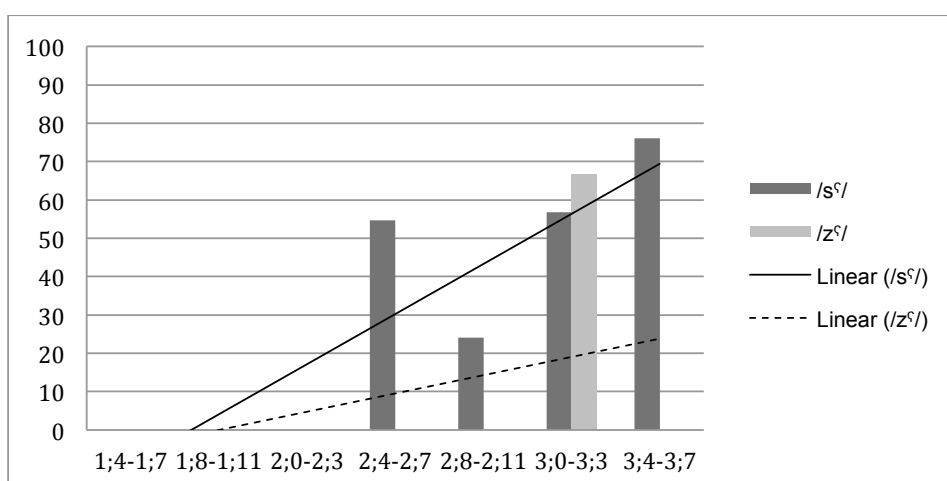
Figure 5.25: The acquisition of /sˤ/ and /zˤ/ across age groups.

The production accuracy of voiceless emphatic /sˤ/ shows remarkable positive trend increasing with age compared to its voiced counterpart /zˤ/ (figure 5.25).

Generally, the reported findings show increase in the production accuracy of most consonants across age bands. Stops and nasals are acquired earliest, followed by approximants and fricatives; while emphatics and affricates are acquired late. A positive correlation between age of onset and production

accuracy has been noted. For example, younger age groups frequently used stops and nasals, as such; stops were produced accurately at an earlier stage compared to other consonants. However, it is important to consider other factors that may influence the production accuracy such as articulatory complexity and acoustic properties of the consonant. For instance, a consonant may be more perceptually salient when it occurs in a geminate environment, and therefore it may be acquired at an earlier stage of development despite its late appearance. Further analysis of consonant production accuracy in relation to its word position would reveal additional accounts of the development of speech sounds in KA.

5.4. Consonant occurrence and production accuracy across word positions

This section presents consonant occurrence count accuracy percentages in four different word positions:

> (1) Syllable-Initial-Word-Initial (SIWI)
> (2) Syllable-Initial-Within-Word (SIWW)
> (3) Syllable-Coda-Within-Word (SCWW)
> (4) Syllable-Coda-Word-Final (SCWF)

The consonants are presented in groups based on production manner. For each group of consonants there will be a graph to demonstrate the number of consonants occurrences across all word positions, followed by a table to demonstrate frequency count and accuracy percentages for each consonant in four word positions.

5.4.1 The occurrences and production accuracy of stops across word positions

Figure 5.26 below demonstrates the number of stop occurrences in spontaneous speech samples of KA speaking children across word positions.
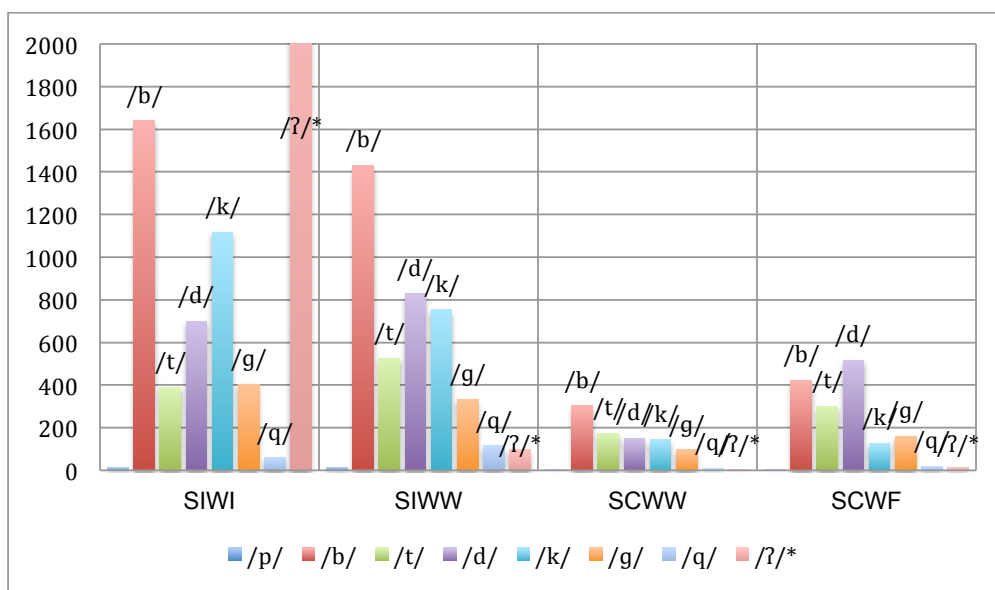
*/ʔ/ occurrences count 3,244 in SIWI.

Figure 5.26: Stop occurrences across word positions.

The graph in Figure 5.26 above is truncated at 2,000 for better illustration of other less frequently occurring consonants. Note that the glottal stop /ʔ/ occurrence count is 3,244 in SIWI position. Vowel-initial syllables in Arabic are prohibited, so a glottal stop is always assumed (and in many cases produced) in syllable onset posotion. The occurrence of /ʔ/ was therefore expected to be high in word-initial position. In KA, most pronouns are produced with initial glottal stop, for example:

/ʔa.nə/	'I/myself'
/ʔin.ta/	'you'
/ʔʊh.wa/	'him'

Additionally, other grammatical characteristics of Arabic result in the frequent use of glottal stop in word initial positions. Glottal stop is often used as a prefix to mark the imperfect indicative bound morpheme to the verb stem. For example:

/k-t-b/ (verb stem)	'write'	→	/ʔak.teb/	'I-write'
/l-ʕ-b/	'play'	→	/ʔal.ʕəb/	'I-play'
/r-k.ðˁ/	'run'	→	/ʔar.keðˁ/	'I-run'

Table 5.21 shows the stops occurrence count and percentage correct consonant (PCC) across word positions.

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Consonant	SIWI		SIWW		SCWW		SCWF	
	PCC		PCC		PCC		PCC	
	No.	%	No.	%	No.	%	No.	%
/p/	14	86	15	87	1	100	2	50
/b/	1,640	91	1,430	89	302	82	422	81
/t/	391	91	527	83	174	83	300	84
/d/	700	74	829	86	150	81	517	82
/k/	1,118	85	753	87	144	94	128	91
/g/	404	46	334	79	97	85	160	46
/q/	59	74	116	41	9	67	19	42
/ʔ/	3,244	93	99	92	3	67	15	60

Table 5.21: Stop production occurrence count and accuracy across word positions

Consonant word position has been shown to influence the accuracy of its production. Table 5.21 shows that /b/, /t/ and /q/ are produced more accurately in SIWI position compared to all other positions. Whereas velar stops /k/ and /g/ are more accurately produced in SCWW positions. All stops were least accurately produced in SCWF positions except for the velar stop /k/, which appears to be produced in syllable coda positions.

5.4.2 The occurrences and production accuracy of nasals across word positions

Figure 5.27 below demonstrates the number of nasal occurrences in spontaneous speech samples of KA speaking children across word positions.
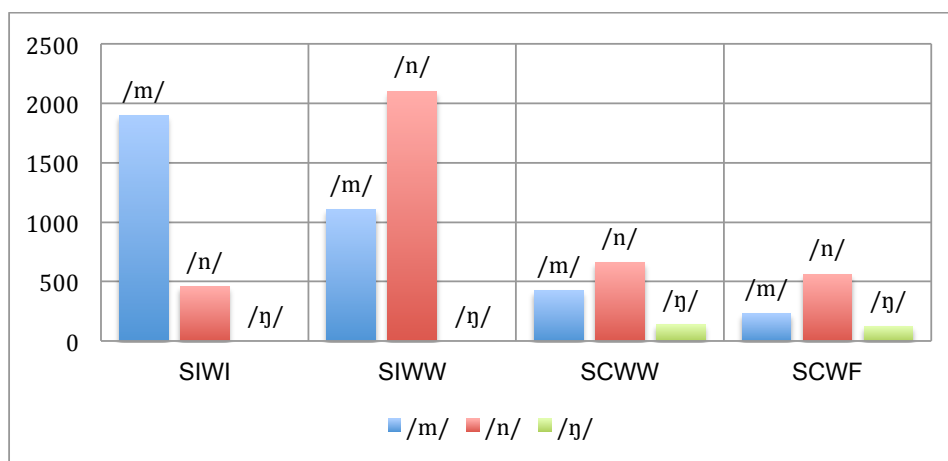
Figure 5.27: Nasal occurrences across word positions.

As seen in figure 5.27, the bilabial /m/ nasal occurs most frequently in SIWI compared to other word positions; whereas /n/ occurs most frequently in SIWW

position. The velar /ŋ/ was excluded from the production accuracy analysis because it was only produced by two out of the 70 children in the sample. Table 5.22 shows the nasals occurrence count and the PCC across word positions.

Consonant	SIWI		SIWW		SCWW		SCWF	
	No.	PCC (%)	No.	PCC (%)	No.	PCC (%)	No.	PCC (%)
/m/	1897	91	1,105	89	421	87	229	83
/n/	457	83	2,101	89	657	83	560	88
/ŋ/					138	64	123	90

Table 5.22: Nasals production occurrence count and accuracy across word positions

The bilabial nasal /m/ was most frequently produced in SIWI position. This could possibly result from the frequent use of KA words with /m/ in SIWI position such as:

/ˈma:.mə/   'mom'

/mad.ˈri.sə/   'school'

/ˈmi.ʃetˤ/   'hair comb'

Another possible reason could be the frequent use of the negation prefixes /mu-/ and /ma-/ in KA, for example:

/ˈma:.bi/   'I don't want'   /ˈma:.dri/   'I don't know '

/mu:.ˈʔa.nə/   'not-me'   /ˈmu:.hni:/   'not here'

The high frequency of /m/ occurrence in SIWI was reflected on its production accuracy in such position. As seen in table 5.22, /m/ was produced most accurately in SIWI (91%).

5.4.3 The occurrences and production accuracy of taps and trills across word positions

Figure 5.28 below demonstrates the number of taps and trills occurrence in spontaneous speech samples of KA speaking children across word positions.

Figure 5.28: Tap & trill occurrences across word positions.

From the graph in figure 5.28, it can be seen that both taps and trills occur most frequently in SIWW position. Note that the overall frequency of taps is higher in all word positions and most notably in SIWW. Table 5.23 shows the taps and trills occurrence count and the PCC across word positions.

Consonant	SIWI		SIWW		SCWW		SCWF	
	No.	PCC (%)	No.	PCC (%)	No.	PCC (%)	No.	PCC (%)
/r/	13	46	176	67	23	30	23	35
/ɾ/	218	51	1,326	56	351	44	514	56

Table 5.23: Tap & trill production occurrence count and accuracy across word positions.

Table 5.23 shows that taps, in prevocalic positions, were more frequently used than trills. However, trills were produced more frequently in SIWW than in SIWI position; but this difference in frequency was not reflected on its production accuracy.

5.4.4 The occurrences and production accuracy of fricatives across word positions

Figure 5.29 below displays the number of fricatives occurrences in spontaneous speech samples of KA speaking children across word positions.

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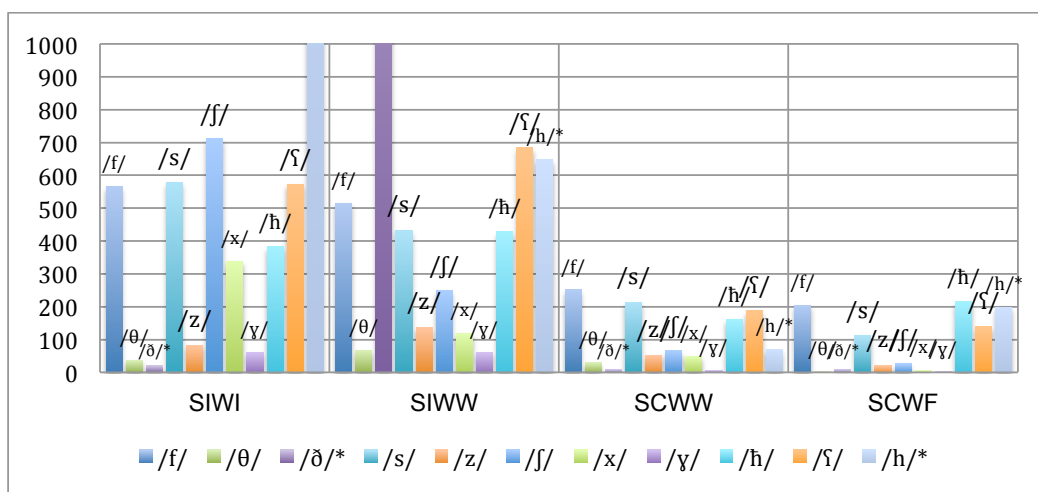
* /h/ and /ð/ occurrence count exceeds 1000 limit on the graph (*/h/*= 3411 and / ð /=3012)

Figure 5.29: Fricative occurrences across word positions.

As seen in Figure 5.29, fricative occurrence in prevocalic positions (SIWI and SIWW) was remarkably higher than its occurrence in postvocalic positions (SCWW and SCWF). The most frequently occurring fricative in SIWI is /h/ followed by /ʃ/ and /s/; whereas in SIWW, /ð/ occurs most frequently followed by /ʕ/ and /h/. Table 5.24 shows the fricative occurrence count and the PCC across word positions.

Consonant	SIWI		SIWW		SCWW		SCWF	
	No.	PCC (%)	No.	PCC (%)	No.	PCC (%)	No.	PCC (%)
/f/	567	76	515	78	251	60	205	89
/θ/	37	54	67	39	30	43	2	50
/ð/	21	29	3012	41	9	67	9	33
/s/	578	77	432	84	214	79	112	86
/z/	82	54	137	72	52	79	21	38
/ʃ/	711	55	248	67	66	64	26	77
/x/	339	62	119	72	49	73	6	83
/ɣ/	61	34	61	56	7	100	1	0
/ħ/	382	65	429	78	161	83	216	74
/ʕ/	573	52	684	71	188	54	139	59
/h/	3164	77	648	75	70	59	199	90

Table 5.24: Fricative production occurrence count and accuracy across word positions

It is apparent from this table that /s/ and /f/ were the two most accurately produced fricatives in SIWI (77% and 76% respectively). In SIWW, /s/, /f/ and /ħ/ were the most accurately produced fricatives (84%, 78%, and 78% respectively). Interestingly, the production of /h/ was more accurate in SCWF position (90%) compared to SIWI position (77%) where it was targeted the most.

5.4.5 The occurrences and production accuracy of approximants and lateral approximants across word positions

Figure 5.30 below shows the frequency of occurrence of approximants and lateral approximants in spontaneous speech samples of KA speaking children across word positions.
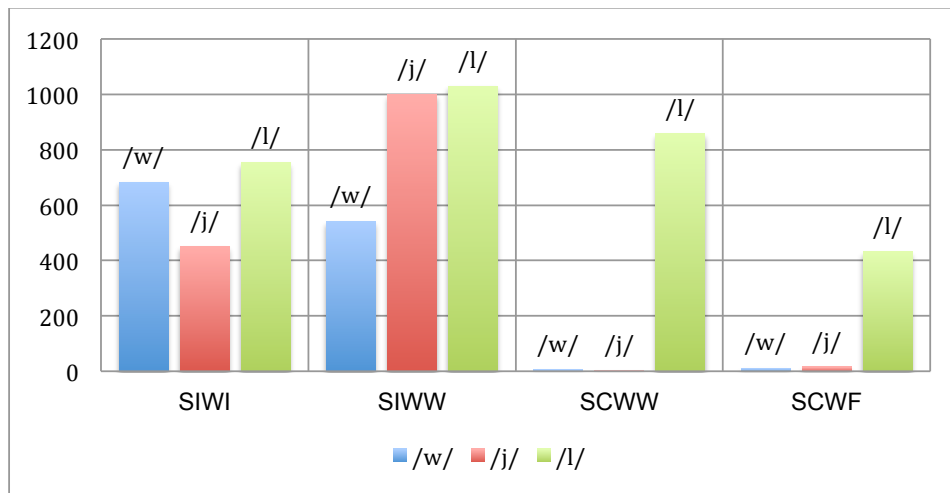
Figure 5.30: Approximants and lateral approximants occurrences across word positions.

Figure 5.30 shows higher occurrence frequency in prevocalic positions (SIWI and SIWW) than in postvocalic positions (SCWW and SCWF). Lateral approximant /l/ occurred in all four positions, whereas the palatal approximant /j/ occurred more frequently in SIWW than in SIWW.

Consonant	SIWI		SIWW		SCWW		SCWF	
	No.	PCC (%)	No.	PCC (%)	No.	PCC (%)	No.	PCC (%)
/w/	682	90	542	92	6	100	10	100
/j/	452	71	1,001	83	4	75	16	88
/l/	754	89	1,029	90	858	86	432	86

Table 5.25: Approximants and lateral approximants production occurrence count and accuracy across word positions.

Table 5.25 shows the approximants and lateral approximants occurrence count and the PCC across word positions. The labiovelar approximant /w/ was most commonly produced in SIWW position, and it was most accurate in this position as well (92%). On the other hand, both /j/ and /l/ were produced more frequently in SIWW position, with an accuracy rate of 83% and 90% respectively.

5.4.6 The occurrences and production accuracy of affricates across word positions

Figure 5.31 below shows the frequency of occurrence of affricates in spontaneous speech samples of KA speaking children, across word positions.
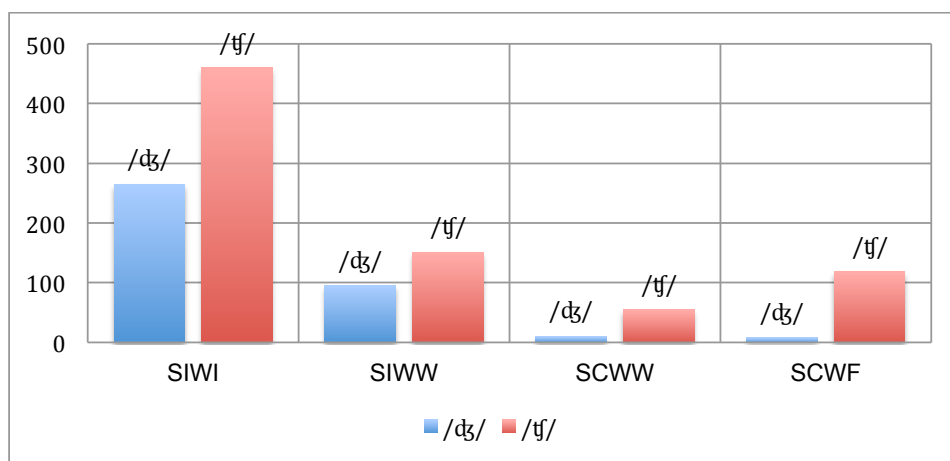
Figure 5.31: Affricate occurrences across word positions.

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There is higher occurrence of affricates in prevocalic positions (SIWI and SIWW) than in postvocalic positions (SCWW and SCWF). Table 5.26 shows the affricates occurrence count and percentage correct consonant (PCC) across word positions.

Consonant	SIWI		SIWW		SCWW		SCWF	
	No.	PCC (%)	No.	PCC (%)	No.	PCC (%)	No.	PCC (%)
/dʒ/	265	32	95	60	10	70	8	25
/tʃ/	460	54	151	61	55	47	118	79

Table 5.26: Affricates production occurrence count and accuracy across word positions.

The table above shows that the number of voiceless affricate /tʃ/ is higher than its voiced counterpart /dʒ/ in all positions. The number of occurrences in SCWF could result from the use of the second person possessive bound morpheme -itʃ in KA. For example:

(1)

a. Noun   ki.ˈtaːb   'book'
b. Noun + adjectival   ki.ˈtaː.bi   'book + 1st person possessive'
c. Noun + feminine possessive   ki.ˈtaː.bitʃ   'book + feminine 2nd
                                                     person singular possessive'

(2)

a. Noun   ˈqa.ˈləm   'pen'
b. Noun + adjectival   ˈqa.lə.mi   'pen + first person possessive'
c. Noun + feminine possessive   ˈqa.lə.mitʃ   'pen+ feminine second
                                                     person singular possessive'

In examples (1) and (2), the [-itʃ] affix is used to mark feminine second person singular possessive. The common use of this affix in KA could also influence the production of /tʃ/ accuracy in SCWF position. As seen in table 5.26, the number of occurrences in SIWI is higher than it is in SCWF, however, it is produced more accurately in the latter position. The occurrence of /tʃ/ in SIWI could possibly result from a dialect specific phonological rule (see section 3.5 of chapter 3 for details and examples).

5.4.7 The occurrence and production accuracy of emphatics across word positions

Figure 5.32 below demonstrates the number of emphatic consonants which occurred in the spontaneous speech samples of KA speaking children across word positions.
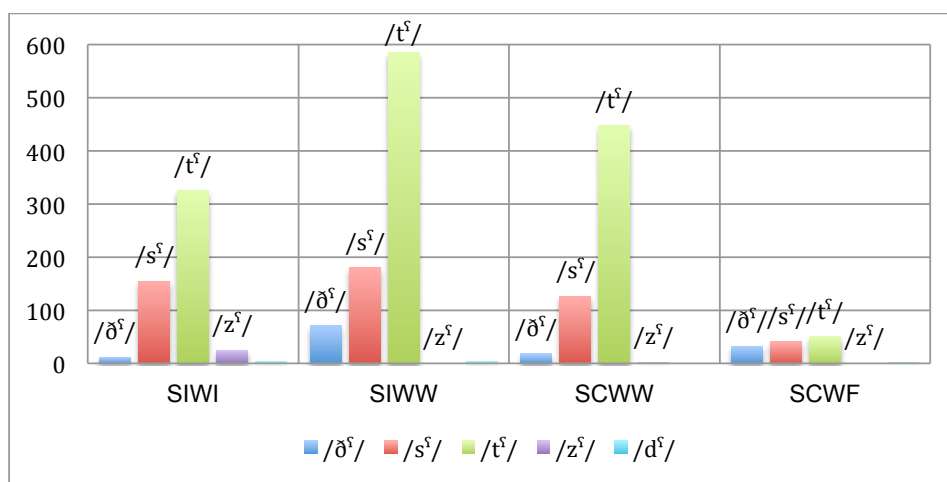
Figure 5.32: Emphatic occurrences across word positions.

Emphatics are more frequent within word positions (SIWW and SCWW) than in SIWI and SCWF positions. For all other consonants, the frequency count was higher in prevocalic than in postvocalic positions. One possible explanation is the frequent occurrence of emphatic geminate in KA.

Table 5.27 shows the emphatics occurrence count and PCC across word positions.

Consonant	SIWI		SIWW		SCWW		SCWF	
	No.	PCC (%)	No.	PCC (%)	No.	PCC (%)	No.	PCC (%)
/ðˤ/	12	50	71	72	18	83	32	72
/sˤ/	155	49	180	50	126	58	41	56
/tˤ/	325	34	585	47	447	53	50	46
/zˤ/	25	56			2	100		
/dˤ/	3	0	3	33			1	100

Table 5.27: Emphatics production occurrence count and accuracy across word positions.

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It can be seen that /tˤ/ production accuracy did not exceed 53% despite its frequent occurrence. In contrast, /ðˤ/ was less frequently used, but it was the most accurately produced emphatic in all positions.

In general, the findings reported in this section are consistent with those of Amayreh and Dyson's (2000) who found that most consonants tend to occur more frequently in prevocalic positions rather than postvocalic. Interestingly, findings reported here did not show linear correlation between frequency of consonant occurrence and its production accuracy of all consonants. For example, /h/ was produced most frequently in SIWI, but most accurately in SCWF; whereas /m/ was produced most frequently and most accurately in SIWI.

These data must be interpreted with caution because individual variation may not allow equal opportunities to exhibit each child's phonological abilities. For example, the number of consonants that have been produced in the 30-minute recording session may not occur in all possible word positions. Similarly, the frequency of a consonant occurrence may not reflect its actual occurrences in the grammar of the language or in other social circumstances. Other environmental factors such as time of the day and child routine disturbances may also significantly influence the child's performance at the time of data collection. Therefore, those findings must be treated with caution when used to represent the phonological development of all KA speaking children.

5.5. Consonant cluster acquisition in KA

The section presents data on the frequency of occurrence and accuracy of production of consonant clusters as produced by KA speaking children. The first part reports on consonant cluster occurrence in relation to word position. The second part reports on consonant cluster accuracy for each age group.

5.5.1 *Consonant cluster occurrence count across word positions*

Spontaneous speech samples of KA children were analysed to identify number of consonant cluster occurrences across words positions; the findings are listed in table 5.28 below.

Word initial		Word medial		Word final clusters	
Consonant cluster	No. occurrences	Consonant cluster	No. occurrences	Consonant cluster	No. occurrences
br-	21	-dɾ-	80	-ŋg[*]	113
ʃl-	19	-kw-	8	-lb	102
dl-	18			-rf	20
kw-	17			-rd	15
sm-	16			-nd	13
sˤb-	11			-ltʃ	12
tr-	11			-nt	9
fr-	10			-ms	8
sk-	10			-lt	6
ʃw-	9			-rʃ	6
sl-	8			-ld	5
sˤɣ-	8				
st-	7				
gl-	6				

Other clusters that occurred less than 5 times:

tw- , sp- , ʃt- , bl- , fl- , kl- , kr- , sw- , ʃdʒ- , fr- , kr- , pr- , sb- , sf- , tˤl-, gr- , ʃf- , ʃk- , ʃʕ-	-ʃw- , -tr- , -bl- , -kl- , -pr- , -sp- , -sˤɣ- , -tˤr-	-rk , -rs , -jn , -ldʒ , -nk, -rd, -sk , -rðˤ , -rz , -bħ , -mt , -mz , -mʃ , -ndʒ , -rk , -wtʃ , -zg , -rn , -ʔb

Tokens	203	103	343
Correct	99	66	159
%Correct	49%	64%	46%

[*] Note: the -ŋg cluster was used by only two out of the seventy children in the current study, thus may not be representative of all children acquiring KA.

Table 5.28: Consonant cluster type and frequency across word positions

Table 5.28 reveals very interesting data. A total of 33 different types of consonant clusters were targeted in word initial position, ten different types in word medial, and 30 different types in word final position. The number of cluster tokens produced in all three positions was 649, that is 3.15% of all target words.

In the current literature, only one study on the development of KA is available (Ayyad, 2011). Data in Ayyad's study was collected using a picture-naming test that contains a single occurrence of 32 different consonant clusters, of which

only eight occurred in word initial-, 19 in word medial-, and six in word final positions. The vast difference between findings of the current study and those of Ayyad (2011) raises the question of how many different clusters could possibly occur in KA. Answering this question could only be possible by examining a representative sample of adult speech, which has not been made available in the current literature.

5.5.2 Consonant cluster occurrence and production accuracy across word positions

Children learning to produce consonant clusters in any language have a challenging task, and those learning Arabic have a uniquely complex situation. The large variety of clusters permissible in KA in all word positions makes even extraordinarily complex. Table 5.29 shows the number of consonant clusters that were produced in three different word positions. Clusters occurring in word-final position are the most frequently targeted clusters in the speech of KA children. Data in table 5.29 show that 53% of all clusters occur in coda position, 31% occur in onset, and only 16% occur in word-medial position. A similar distribution pattern was also reported to occur in the speech of children acquiring other languages (e.g. English: Dyson, 1988; German: Lleo & Prinz, 1996;); where coda clusters appear earlier and are acquired before other positions.

Age	Word Initial CC			Word Medial CC			Word Final CC		
	Count	Correct	%Correct	Count	Correct	%Correct	Count	Correct	%Correct
1;4-1;7	6	1	17	3	1	33	10	0	0
1;8-1;11	6	1	17	0	0	0	67	35	52
2;0-2;3	8	0	0	1	0	0	2	1	50
2;4-2;7	45	24	53	24	15	63	111	29	26
2;8-2;11	34	5	15	9	1	11	34	13	38
3;0-3;3	50	39	78	25	15	60	40	29	73
3;4-3;7	54	29	54	41	34	83	79	52	66
Total	203	99	49	103	66	64	343	159	46

Table 5.29: Consonant cluster (CC) occurrences count and production accuracy across word positions

Data from table 5.29 show marked positive association between number of cluster occurrences and age. Children in the youngest age group targeted far fewer clusters compared to the eldest group in all word positions. Similarly, the

accuracy of cluster production increased with age. It is also evident that word medial clusters were more likely to be produced accurately than word initial and word final clusters. However, word-final clusters appeared earlier than other positions and were produced with higher accuracy. For example, the 1;8-1;11 age group targeted 67 word-final clusters with 52% accuracy; whereas at the same age, only 6 clusters were targeted in word-initial (1% accuracy) and none were targeted in word-medial position.

The ability to produce consonant clusters is reported to emerge when children acquiring English are around 2 years of age (e.g. French, 1989; Lleo & Prinz, 1996) during the phase that Ingram (1991) refers to as the "word spurt". The data presented in table 5.29 supports this statement. The apparent increase in number of consonant cluster tokens targeted by children in the 2;4-2;7 group coincides with the age at which KA children showed a dramatic incline in the number of the produced words (see table 5.2).

5.6.   Error pattern analysis

The following subsections present findings from segmental and prosodic error pattern analysis. Each error pattern is defined, followed by a table and a graph to illustrate developmental progression, and concluded with examples of most frequent error patterns. All examples were extracted from the actual data. Hereafter, the slanted brackets " / / " are used to represent target realisation, while the square brackets " [ ] " represent actual realisations.

5.6.1. Segmental error patterns

5.6.1.1.   Fronting:
Fronting errors are when consonants are produced anterior, or forward of, the standard production place. Voicing and manner were disregarded in this calculation. For example, /g/ realised as [k] and /d/ realised as [t]. The findings are summarised in table 5.30 below.

Fronting	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	205	180	91	301	192	174	98	1441
No. targets	2,407	2,248	3,101	9,031	8,466	8,088	9,709	43,050
Frequency	9%	8%	3%	3%	2%	2%	1%	3%

Table 5.30: Fronting error pattern occurrence and frequency across age groups.

From table 5.30, it can be seen that fronting error pattern reduced in frequency in correlation with age. The youngest age group produced this error in 9% of the attempted target words, whereas the eldest group only produced this type of error in 1% of target words. The developmental progression illustrated in figure 5.33 shows linear reduction in frequency with age.
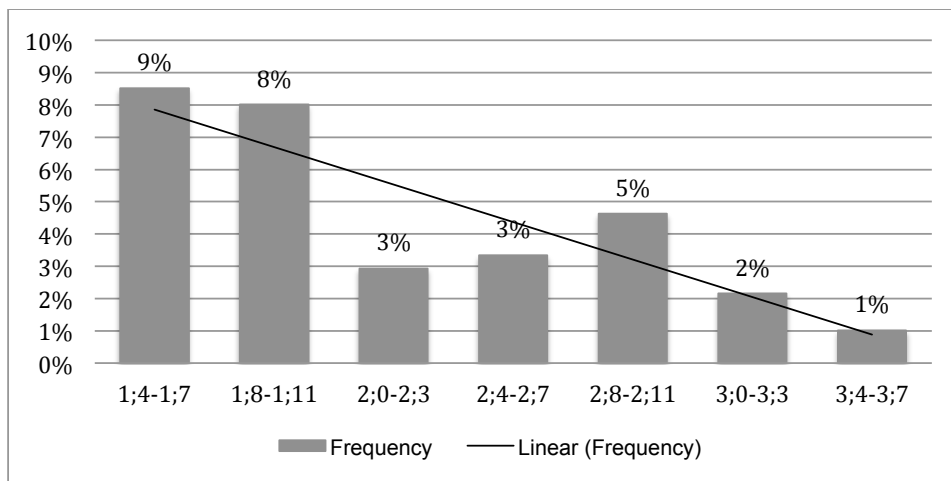
Figure 5.33: Fronting error pattern occurrence frequency across age groups.

The most commonly produced fronting errors are the following:

- /ʃ/ realised as [s] in 12% of fronting errors:

  e.g.   /ˈjam.ʃi/   →   [ˈjəm.si]   'walk' + masculine
  /ˈʃi.nʊ/   →   [ˈsi.nʊ]   'what'
  /fraːʃ/   →   [fraːs]   'bed'

- /k/ realised as [t] in 5% of fronting errors:

  e.g.   /ˈkaː.hi/   →   [ˈtaː.hi]   'here it is' + feminine
  /ʃuk.ˈran/   →   [ut.ˈtan]   'thanks'

5.6.1.2.   Backing:

Backing errors are when consonants are produced further back in the oral cavity than the standard production. Voicing and manner were disregarded in

this calculation. From table 5.31, it can be seen that backing error pattern reduced in frequency in correlation with age. The youngest age group produced this error in 6% of the attempted target words, whereas the eldest group only produced this type of error in 4% of target words.

Backing	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	154	161	207	465	390	255	369	2001
No. targets	2,448	2,240	3,202	9,416	8,554	8,473	10,036	44,369
Frequency	6%	7%	6%	5%	5%	3%	4%	5%

Table 5.31: Backing error pattern occurrence and frequency across age groups.

The developmental progression is illustrated in figure 5.34, it shows linear reduction in frequency with age despite some apparent fluctuation in occurrence frequencies in the younger age groups.
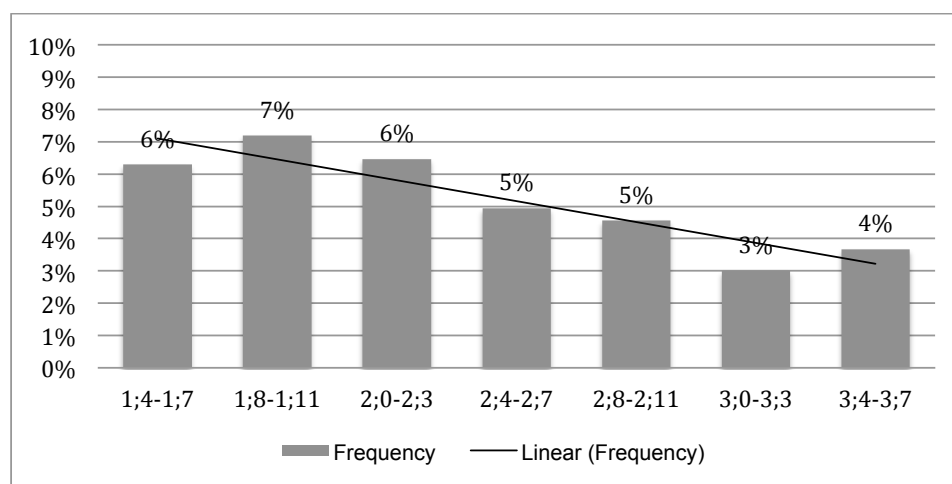
Figure 5.34: Backing error pattern occurrence frequency across age groups.

The most frequently occurring backing error was /ð/ → [d], which also exhibit fricative stopping error, counted for 50% of all backing errors. /ʕ/ → [ʔ] errors, on the other hand, counted for 13% of all backing errors. All the other backing errors were produced in less than 5% of target words (e.g. /θ/ → [s], /d/ → [k], /d/ → [g]).

The Arabic pronouns /ˈhaː.ðə/ and /ˈhaː.ði/ were frequently used by children in all age groups; this was also reflected in the frequency of /ð/ → [d] errors. Such as in the following examples:

/ˈhaː.ðə/	→	[ˈhɑ.də]	'this' + masculine
/ˈhaː.ði/	→	[ˈhaː.di]	'this' + feminine

This error also occurred in other KA words such as:

/ˈʃaː.ði/	→	[ˈʃaː.di]	'monkey'
/ðiːb/	→	[diːb]	'wolf'
/ðib.ˈbaː.nə/	→	[dʌb.ˈbaː.nə]	'fly'
/ʧi.ˈðiː/	→	[si.ˈdiː]	'like this'

The second most commonly used backing error was /ʕ/ → [ʔ], which also exhibit fricative stopping error. The following are some commonly used KA words in which the error occurs:

/ʕa.ˈtˤiː.ni/	→	[ˈʔa.ti]	'give me' + feminine
/ʕilʧ/	→	[ʔəjʦ] / [ʔiʧ]	'bubble gum'
/ˈma.ʕə/	→	[ˈma.ʔə]	'with'
/jaʕ.ˈguː.bi/	→	[jaʔ.ˈguː.bi]	'Yacoubi' (masculine name)
/ʕu.ˈmar/	→	[ʔu.ˈmɑl]	'Omar' (masculine name)

5.6.1.3. Stopping:

Stopping errors are when fricatives and affricates are realised as stops. Voicing and place were disregarded in this calculation. Table 5.32 shows the frequency in which this error pattern produced by KA speaking children.

Stopping	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	213	250	230	508	498	218	338	2255
No. targets	766	825	1,343	3,619	3,656	3,284	4,156	17,649
Frequency	28%	30%	17%	14%	14%	7%	8%	13%

Table 5.32: Stopping error pattern occurrence and frequency across age groups.

The developmental progression is illustrated in figure 5.35, it shows linear reduction in frequency with age.

Figure 5.35: Stopping error pattern occurrence frequency across age groups.

The most frequently occurring stopping error was /ð/ → [d], which also exhibited a backing error and accounted for 48% of all stopping errors. /ʕ/ → [ʔ] and /ʧ/ → [t] errors counted for 12% and 8% of all stopping errors respectively. All the other stopping errors were produced in less than 5% of target words (e.g. /ɣ/→/k/, /s/→[t], /ʤ/ → [d]). The following examples illustrate the most frequently produced errors:

/ð/→[d]	/ˈhaː.ði/	→	[ˈhaː.di]	'this' + feminine
	/ˈʧi.ði/	→	[ˈʧi.di]	'like this'
/ʕ/→[ʔ]	/ˈbaʕ.dɛːn/	→	[ˈbaʔ.dɛn] / [ba.ˈdɛːn]	'after'
	/ʕilʧ/	→	[ʔits]	'chewing gum'
/ɣ/→/k/	/ɣa.ˈsːil/	→	[kə.ˈsːeː]	'wash'
/s/→[t]	/ˈʔa.səd/	→	[ˈʔa.tʌd]	'lion'
/ʧ/ → [t]	/fiʧ/	→	[fit]	'open' + masculine

Stopping of the voiced velar fricative /ɣ/ → [q] was not counted as error in this analysis as both consonants are used interchangeably in different dialects of KA, e.g., /bɔr.tu.ˈɣaːl/-/bɔr.tu.ˈqaːl/ 'orange'; /ˈqa.ləm/-/ˈɣa.ləm/ 'pen'; and /ˈɣa.nəm/-/qa.nəm/ 'sheep'.

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5.6.1.4. Spirantization:

Spirantization error patterns are when stops are realised as fricatives. Children in all groups produced this error pattern in low frequency as shown in table 5.33 below.

Spirantization	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	11	4	13	12	21	25	11	97
No. targets	901	1,036	1,378	2,754	2,508	2,701	2,943	14,221
Frequency	1%	0%	1%	0%	1%	1%	0%	1%

Table 5.33: Spirantization error pattern occurrence and frequency across age groups.

The following examples illustrate the most commonly produced spirantization errors:

- /b/ realised as [β] in 29% of spirantization errors;

/baːb/	→	[βaːβ] - [baːβ] - [βaːb]	'door'
/ˈbɛː.biː/	→	[ˈbɛː.βiː]	'baby'
/ˈʔa.bi/	→	[ˈʔa.βi]	'I want'

- /d/ realised as [ð] in 10% of spirantization errors;

/di.ˈdːiːd/	→	[ˈdiː.ðiːð]	'car sound'
/ˈðˤəf.daʕ/	→	[ˈðˤəf.ðaʕ]	'frog'
/ˈdaːx.lə/	→	[ˈðaːk.la]	'inside it' + masculine 2nd person
/ʔi.ˈdɛː.də/	→	[ʔi.ˈðɛː.ðə]	'grandma'

- /ʔ/ realised as [h] in 6% of spirantization errors;

/ˈʔa.səd/	→	[ˈha.səd]	'lion'
/ˈʔaː.nə/	→	[ˈhaː.nə]	'I'
/ʔa.ˈkil/	→	[ha.ˈki]	'food'
/ˈʔad.ri/	→	[ˈhad.ri]	'I know'
/ˈʔas.wad/	→	[ˈhaθ.wəd]	'black'

Other spirantization errors occurred less commonly (less than 5%) such as the following examples:

- /d/→[s]

| /ˈdaː.nə/ | → | [ˈsɑː.nə] | 'Dana' (name) |

- /ʔ/ → [ʕ]

/ˈʔər.bɑ.ʕə/	→	[ˈʕəː.bʌʔ]	'four'
/laʔ/	→	[laʕ]	'no'
/wə.ˈfaː.ʔ/	→	[wə.ˈfaːʕ]	'Wafaa' (name)
/ʔəl.ˈwɑːn/	→	[ʕəl.ˈwɑːl]	'colours'
/ba.ˈtˤɪːʔ/	→	[ba.ˈtˤɪːʕ]	'slow'

Note that /ʔ/ → [h] errors were only produced in word initial position, while other spirantization errors occurred in all word positions. This is because both consonants are glottal, and in word-initial position often mirror the patterns of the following glottal consonant.

5.6.1.5.   Vocalization:

Vocalization error patterns are when liquids are realised as vowels when the apical gesture is dropped but the dorsal gesture remains. This error is not expected to be found in the speech of children acquiring Arabic due to the clear /l/ realisations. Thus, there were no vocalization errors in the data collected for the current study. The number of possible targets is listed in table 5.34.

Vocalization	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	0	0	0	0	0	0	0	0
No. targets	805	529	988	3,062	2,542	2,911	3,386	14,223
Frequency	0%	0%	0%	0%	0%	0%	0%	0%

Table 5.34: Vocalization error pattern occurrence and frequency across age groups.

5.6.1.6.   Nasalisation:

Nasalisation errors result from realisation of consonants as homorganic nasals sharing a similar place of articulation. That is bilabial stop /b/ realised as /m/ and alveolar /d/ realised as /n/. Data in table 5.34 below shows that nasalisation error pattern is uncommon in KA children speech.

Nasalisation	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	0	0	0	25	5	4	5	39
No. targets	406	320	774	1,198	1,233	1,165	1,408	6,504
Frequency	0%	0%	0%	2%	0%	0%	0%	1%

Table 5.35: Nasalisation error pattern occurrence and frequency across age groups.

Out of total 39 nasalisation errors, 22 errors resulted from nasalisation of /b/ (56%) and 17 errors resulted from /d/ (44%) nasalisation. The following examples illustrate common nasalisation error patterns produced by KA speaking children:

/b/→ [m]   /bɔr.tʌ.ˈqaːl/ →   [mɔr.tʌ.ˈqaːl] 'oranges'
                 / la.ˈʕab.na/ →   [la.ˈʕam.na] 'we played'
                 /ˈħa.bːa/   →   [ˈħa.mːa]   'kiss'

	/ʕa.ˈbːuːd/	→	[ʕa.ˈmːuːt]	'Abbod' (name)
/d/→[n]	/du.ˈwːa/	→	[nu.ˈwːa]	'medicine'
	/ʕa.ˈbːuː.di/	→	[ʕa.ˈbːuː.ni]	'Abbodi' (name)
	/ˈʕin.da/	→	[ˈʕid.na]	'with him'

5.6.1.7. De-nasalisation:

De-nasalisation errors result from the realisation of nasals as homorganic stops, sharing a similar place of articulation. This type of error was rarely exhibited by all groups of children. Table 5.36 shows the frequency in which this error pattern produced by KA speaking children.

De-nasalisation	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	6	7	5	10	16	5	24	73
No. targets	578	353	713	1,577	1,370	1,576	1,704	7,871
Frequency	1%	2%	1%	1%	1%	0%	1%	1%

Table 5.36: De-nasalisation error pattern occurrence and frequency across age groups

Out of total 73 de-nasalisation errors, 50 errors resulted from de-nasalisation of /m/ (68%) and 23 errors resulted from /n/ (32%) de-nasalisation. The following examples illustrate de-nasalisation error patterns produced by KA speaking children:

/m/→ [b]	/ˈmaː.bi/	→	[ˈbaː.bi]	'I don't want'
	/maːj/	→	[baːj]	'water'
	/ˈmaː.ma/	→	[ˈbaː.mə]	'mum'
	/ˈɣaː.nim/	→	[ˈkaː.nib]	'Ghanim' (name)
	/tˤu.ˈmaː.tˤa/	→	[tu.ˈbaː.də]	'tomato'

/n/→ [d]	/ˈʔaː.na/	→	[ˈʔɑː.də]	'me'
	/ˈʔin.tiː/	→	[ˈʔe.diː]	'you'
	/ˈwɛː.na/	→	[ˈwɛː.də]	'where is it' + masculine

5.6.1.8. Affrication:

Affrication errors are when affricates are replaced by fricatives. Table 5.37 shows the frequency in which this error pattern produced by KA speaking children.

Affrication	1;4-1;7	1;81;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	3	0	0	12	7	13	17	52
No. targets	203	290	528	1,352	1,360	1,263	1,595	6,591
Frequency	1%	0%	0%	1%	1%	1%	1%	1%

Table 5.37: Affrication error pattern occurrence and frequency across age groups.

Out of total 52 nasalisation errors, 39 errors (75%) resulted from affrication of /ʃ/ being realised as [ʧ] and 5 errors (10%) resulted from /ʃ/ being realised as [ʦ] nasalisation. The following examples illustrate affrication error patterns produced by KA speaking children:

/ʃ/→[ʧ]	/ʃuːt/	→	[ʧuːʃ]	'kick' + masculine
	/ʕɛːʃ/	→	[ʕɛːʧ]	'rice'
	/ˈʃi.nuː/	→	[ˈʧi.nuː]	'what'
	/fa.ˈraː.ʃə/	→	[fa.ˈraː.ʧə]	'butterfly'

/ʃ/→[ʦ]	/ʃift/	→	[ʦi]	'I saw'/ 'you saw'
	/ˈʃin.huː/	→	[ˈʦin.huː]	'what' + masculine
	/ʃuːf/	→	[ʦuːf]	'look' + masculine
	/ˈʃɒː.ka/	→	[ˈʦɒː.ka]	'fork'

Some acceptable affrication in KA were identified and excluded from the error analysis results. For example:

	/ˈʃuː.fi/	→	[ˈʧuː.fi]	'look' + present tense + feminine
	/ʃift/	→	[ʧift]	'I saw'/ 'you saw'

In this example, affrication of /ʃ/ → [ʧ] is acceptable in this specific lexical item. The frequency of this error could possibly result from overgeneralization of this pattern. For instance, if a child was exposed to the two variants of the word /ʃift/, he or she may apply affrication to the /ʃ/ consonant in other lexical items.

5.6.1.9. De-affrication:

De-affrication errors are when affricates realised as fricatives. Table 5.38 shows the frequency in which this error pattern produced by KA speaking children.

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De-affrication	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
errors	0	0	0	12	46	14	11	83
targets	73	87	44	191	333	236	253	1,217
Frequency	0%	0%	0%	6%	14%	6%	4%	7%

Table 5.38: De-affrication error pattern occurrence and frequency across age groups.

The two most frequently produced de-affrication errors were the realisation of /ʧ/ as [s] and [ʃ]. Out of total 83 deaffrication errors, the voiceless affricate was realised as [s] 37 times (45%), and [ʃ] 35 times (42%). Other less frequent de-affrication errors were /ʤ/ realised 9 times as [ð] and [z] (11%). The following examples illustrate common de-affrication error patterns:

/ʧ/→[s]	/ˈʧi. ði:/	→	[ˈsi.di:]	'like this' (most frequent token)
	/fi.ˈʧ:i:/	→	[bit.ˈsi:]	'open it' + feminine
	/di:ʧ/	→	[di:s]	'rooster'

/ʧ/→[ʃ]	/ˈʧi.ði:/	→	[ˈʃi.di:] / [ˈʃi.ði:]	'like this'
	/ʧalb/	→	[ʃɛlp]	'dog'
	/ʕilʧ/	→	[ʕilʃ]	'chewing gum'

/ʤ/→[z]	/di.ˈʤa:ʤ/	→	[zi.ˈza:ʣ]	'chicken'
	/ˈʤi:.bi/	→	[ˈzi:.bi]	'get it' + feminine
	/ˈʤa.mal/	→	[ˈza.məl]	'camel'

5.6.1.10. De-emphasis:

De-emphasis error pattern result from loss of the secondary articulation of emphatic consonants /tˤ, dˤ, ðˤ, sˤ, zˤ/. Table 5.39 shows the frequency in which this error pattern produced by KA speaking children.

De-emphasis	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	100	51	47	277	185	58	49	767
No. targets	134	83	61	565	417	438	449	2,147
Frequency	75%	61%	77%	49%	44%	13%	11%	36%

Table 5.39: De-emphasis error pattern occurrence and frequency across age groups.

The developmental progression is illustrated in figure 5.36, it shows linear reduction in frequency with age.
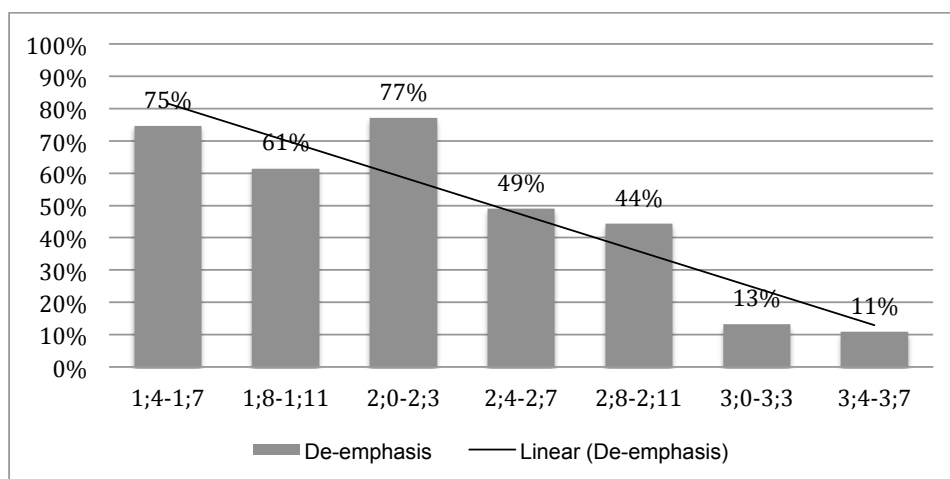
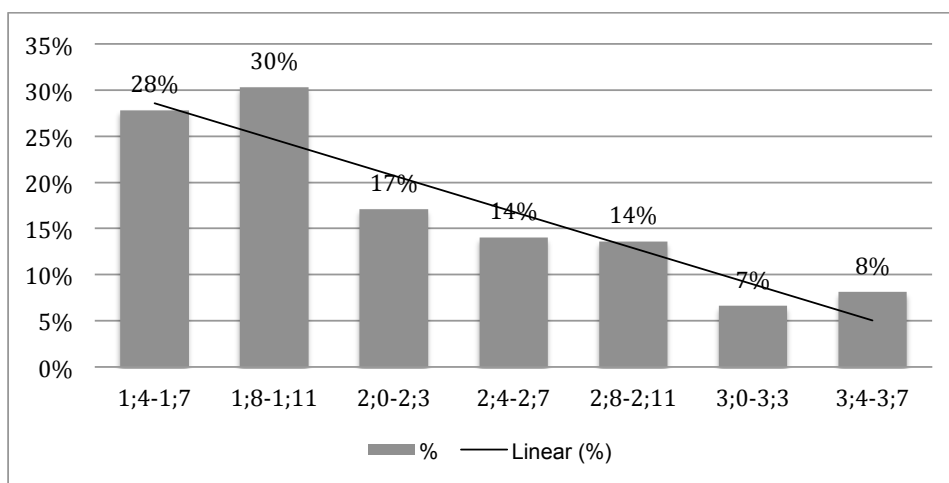Figure 5.36: De-emphasis error pattern occurrence frequency across age groups.

De-emphasis errors are the most commonly occurring error pattern in the speech of all age groups. The two consonants that were most commonly produced in error are /tˤ/ and /sˤ/, with frequencies of 80% and 19% respectively; and are illustrated in the following examples:

- /tˤ/ → [t]   /tˤaːħ/   →   [taːħ]   'he fell'
                 /tˤig/   →   [tiː]   'hit'
                 /ˈba.tˤːə/   →   [ˈba.tːə]   'duck'
                 /bɔ.ˈtˤaː.tˤə/   →   [bɔ.ˈtaː.tə] 'potato'
                 /ˈgɛtˤ.wɑ/   →   [ˈgɛt.wɑ]   'cat'

- /sˤ/ → [s]   /je.ˈsˤiːr/   →   [e.ˈsiːr]   'it happens'
                 /dej.nə.ˈsˤuːr/ →   [dej.ə.ˈsuːl] 'dinosaur'
                 /ʃə.ˈbːaː.sˤə/   →   [ˈbaː.sə]   'hair band'
                 /qi.ˈsˤːa/   →   [ki.ˈsːa]   'story'
                 /xə.ˈlɑːsˤ/   →   [xə.ˈlɑːs]   'done'

5.6.1.11. Gliding:

Gliding error patterns calculation was based on the percentage in which /r/, /ɹ/, /ɾ/ and /l/ were realised as glides ([j] and [w]). Table 5.40 shows the frequency in which this error pattern produced by KA speaking children.

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Gliding	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. Errors	45	6	26	39	42	13	39	210
No.Targets	227	177	275	1485	1,172	1,339	1,691	6,366
Frequency	20%	3%	9%	3%	4%	1%	2%	3%

Table 5.40: Gliding error pattern occurrence and frequency across age groups.

The developmental progression is illustrated in figure 5.37, it shows linear reduction in frequency with age.
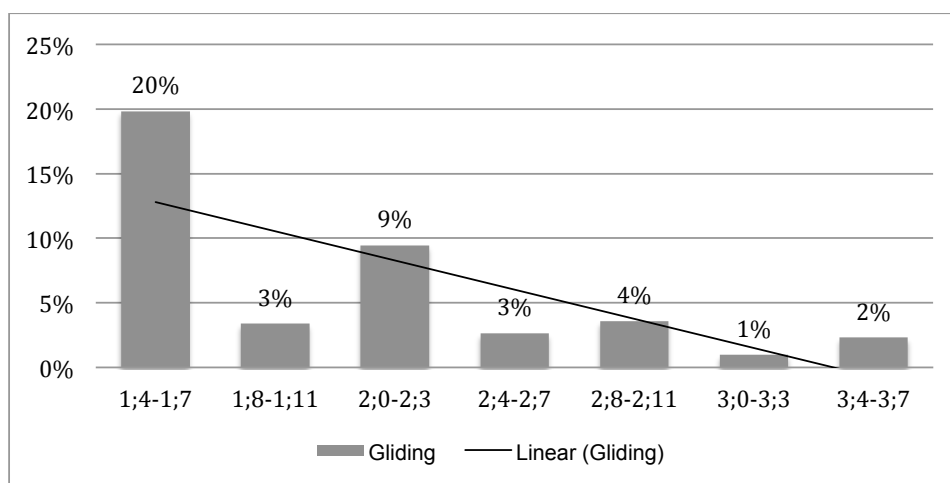
Figure 5.37: Gliding error pattern occurrence frequency across age groups.

Gliding errors were frequently produced by the youngest age group (1;4-1;7). The most frequently affected consonant was /r/. Out of total 224 gliding errors, /r/ was realised as [j] and [w] in 108 (48%) and 73 (33%) of times respectively. Most frequently produced gliding errors are the following:

/r/→[j]	/ˈko.ra/	→	[ˈkɒ.jə]	'ball'
	/ˈħɔm.ra/	→	[ˈhəw.jə]	'lipstick'
	/ˈgaː.ri/	→	[ˈtaː.ji]	'bicycle'
	/ˈmar.jəm/	→	[ˈma.jːəm]	'Mariam' (name)
	/ke.ˈbiː.ra/	→	[ke.ˈbiː.jə]	'big' + feminine
	/ˈzˤɣiː.ra/	→	[ˈtʃiː.ja]	'small' + feminine
	/ˈwar.də/	→	[ˈwɒj.də]	'flower'
	/ʔar.ˈnab/	→	[ʔaj.ˈnab]	'rabbit'

/r/→[w]	/ˈko.ra/	→	[ˈgo.wa] / [ˈdo.wa]	'ball'
	/ˈruː.ħaj/	→	[ˈwuː.ħaj]	'go' + feminine
	/ˈmaː.dri/	→	[ˈmaː.dwi]	'I don't know'
	/xə.ˈruːf/	→	[ħə.ˈwuːf]	'sheep'

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5.6.1.12. Lateralization of /r/:

Lateralization of /r/ error pattern are identified when /r/ is realised as /l/ in any word position. Table 5.41 shows the frequency in which this error pattern produced by KA speaking children.

/r/ lateralization	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. Errors	16	32	20	131	120	27	133	479
No.Targets	89	70	106	558	539	553	633	2548
Frequency	18%	46%	19%	23%	22%	5%	21%	19%

Table 5.41: Lateralization of /r/ error pattern frequency of occurrence across age groups.

The developmental progression is illustrated in figure 5.38 shows a great deal of fluctuation with age.
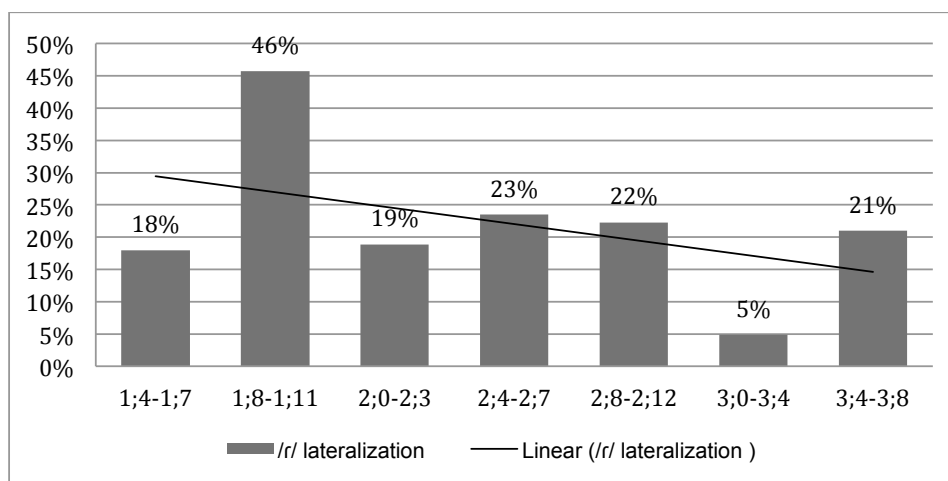
Figure 5.38: Lateralization of /r/ error pattern frequency of occurrence across age groups.

The apparent frequency fluctuation can be attributed to the number of target /r/ occurrence in the child spontaneous speech sample. For example, children in the 2;0-2;3 age group targeted only 70 /r/ tokens during the 30-minute recording session, almost half of the targets were realised as [l] (i.e. 46%); whereas children in the 1;4-1;7 age group targeted /r/ 89 times, and realised 16 out of 89 tokens as /l/ (i.e. 18%). The following examples illustrate the most commonly produced errors:

/ˈʔax.ðˤar/	→	[ˈʔə.ħə.dal]	'green'
/ tˤɛːr/	→	[stɛːl] / [tɛːl]	'bird'
/ tʕarf/	→	[tɛːlf]	'she-knows'
/ tiʃ.ˈtar.li/	→	[ʔi.ˈtːe.lːiː]	'you-buy-me' (something)
/ˈsaː.ra/	→	[ˈsaː.la]	'Sara' (name)
/ˈriː.la/	→	[ˈliː.la]	'his-feet'

This error pattern was observed in all word position as illustrated in the above examples. The last example in the above list could also resemble assimilation error pattern.

5.6.1.13. Glottal replacement:

Glottal replacement errors are when a consonant is realised as a glottal stop [ʔ]. From table 5.42, it can be seen that the frequency of this error pattern is relatively low.

Glottal Replacement	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	70	58	42	136	48	47	16	417
No. targets	2,224	1,970	3,009	8,397	7,644	7,523	8,944	39,711
Frequency	3%	3%	1%	2%	1%	1%	0%	1%

Table 5.42: Glottal replacement error pattern occurrence and frequency across age groups

The developmental progression is illustrated in figure 5.39, it shows linear reduction in frequency with age.
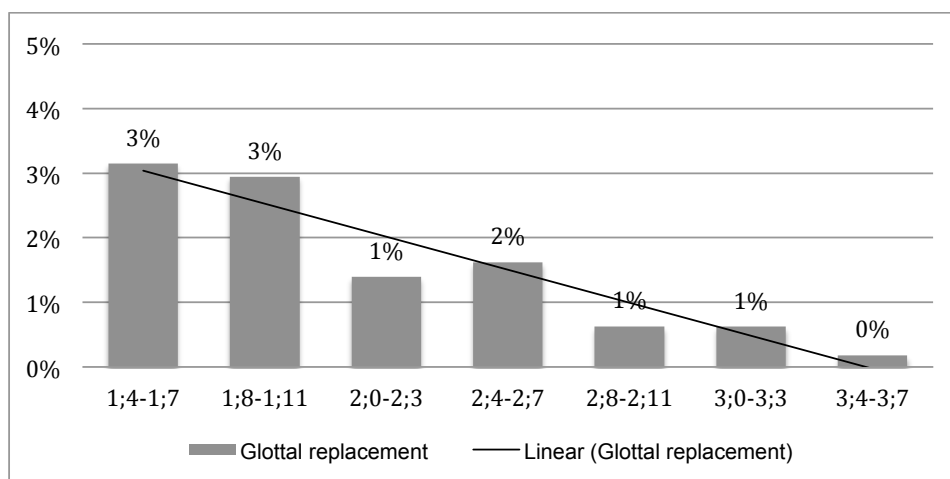
Figure 5.39: Glottal replacement error pattern occurrence frequency across age groups

Children in all age groups produced a total of 471 glottal replacement errors. The voiced pharyngeal and voiceless glottal fricatives, /ʕ/ and /h/, were the two most commonly affected consonants making up 63% and 22% of glottal replacement errors respectively. Both /ʕ/ and /h/ were the two consonants that were most frequently realised as glottal stop. Glottal replacement errors also account for fricative stopping error patterns. The following examples illustrate the most commonly produced errors:

/ʕ/→ [ʔ]	/ʕiltʃ/	→	[ʔiltʃ]	'chewing gum'
	/ʕa.ˈtˁiː.ni/	→	[ʔa.ˈtiː.ni]	'give-me' + feminine
	/ˈsaː.ʕə/	→	[ˈsaː.ʔə]	'clock' / 'watch'
	/ˈjxa.riʕ/	→	[ˈjkə.ləʔ]	'its-scary' + masculine
/h/→ [ʔ]	/ˈhaː.ði/	→	[ˈʔaː.di]	'this' + feminine
	/hniː/	→	[ʔniː]	'here'
	/ˈkaː.hi/	→	[ˈkaː.ʔi]	'here-it-is' + feminine

5.6.1.14. Voicing error patterns:

      i.   Postvocalic devoicing:

Postvocalic devoicing errors are when word final voiced consonants are realised as their voiceless counterparts. Data in table 5.43 show that children did not produce this type of error before the age of two. The frequency of occurrence was at its highest between 2;4-2;7 and reduced to 1% by the age of 3;4-3;7.

WF devoicing	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	0	0	3	43	20	14	4	84
No. targets	44	94	84	393	360	463	456	1,894
Frequency	0%	0%	4%	11%	6%	3%	1%	4%

Table 5.43: Word final devoicing error pattern occurrence and frequency across age groups

The developmental progression is illustrated in figure 5.40, it shows linear reduction in frequency with age.
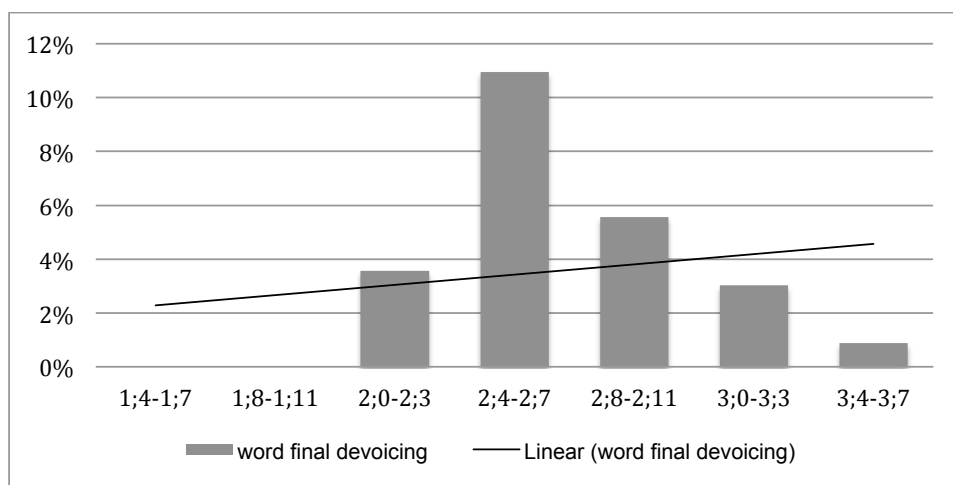
Figure 5.40: Word final devoicing error pattern occurrence frequency across age groups.

The most frequently produced word final devoicing errors were the realisation of /d/ as [s] and [t]. Out of total 84 final devoicing errors, /d/ was realised as [t] 27 times (32%), [ʕ] realised as [ʔ] 21 times (25%), and /g/ realised as [k] 13 times (16%). The following examples illustrate the most commonly produced errors:

/d/ → [t]	/ˈʔəs.wəd/	→	[ˈʔəs.wət]	'black'
	/ˈwa.ləd/	→	[ˈwa.lət]	'boy'
	/qird/	→	[qirt]	'monkey'
	/ˈʔa.səd/	→	[ˈʔɛ.sɛt] / [ˈʔa.təːt]	'lion
/ʕ/ → [ʔ]	/ˈjxə.rɪʕ/	→	[ˈjkə.ləʔ]	'scary'
	/ˈtˤa.lːəʕ/	→	[ˈta.lːəʔ]	'look'
	/ˈðˤif.dəʕ/	→	[ˈsˤəv.dɛʔ] / [ˈef.daʔ]	'frog'

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/g/→[k]	/fɔːg/	→	[fɔːk]	'up'
	/tˤig/	→	[tik]	'hit'
	/ˈʔəz.rəg/	→	[ˈʔəð.rək]	'blue'

ii.   Prevocalic voicing:

Prevocalic voicing errors are when voiceless consonants occurring in prevocalic positions are realised as voiced ones. Place and manner were disregarded in this analysis. Table 5.44 shows the frequency in which this error pattern produced by KA speaking children. The frequency of this error pattern was relatively low, reaching its maximum of 6% at the age of 1;4-1;7.

Prevocalic voicing	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	50	42	4	83	49	65	16	309
No.targets	773	1,022	1,163	3,412	3,210	2,996	3,423	15,999
Frequency	6%	4%	0%	2%	2%	2%	0%	2%

Table 5.44: Prevocalic voicing error pattern occurrence and frequency across age groups.

The developmental progression is illustrated in figure 5.41, it shows linear reduction in frequency with age.
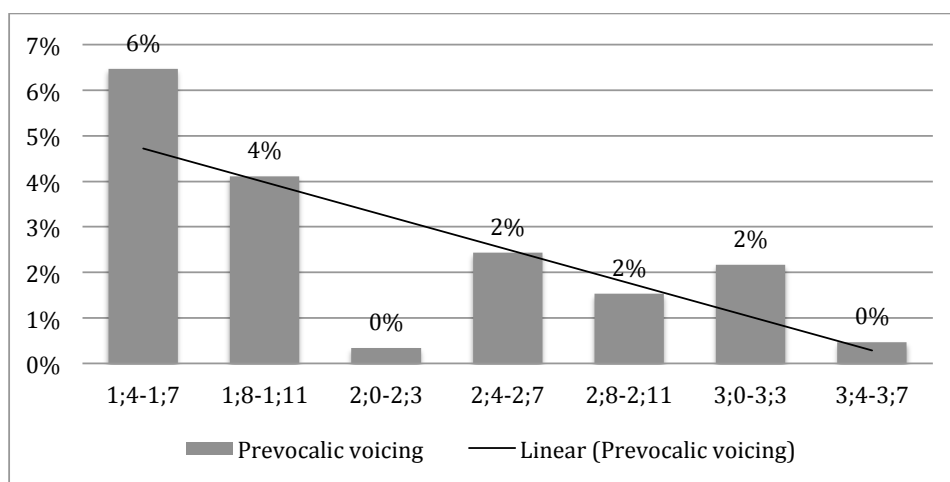
Figure 5.41: Prevocalic voicing error pattern occurrence frequency across age groups

The most frequently produced prevocalic voicing errors were the realisation of /k/ as [g]. Out of total 309 final devoicing errors, /k/ was realised as [g] 40 times (13%), [t] realised as [d] 22 times (7%), and /f/ realised as [b] 22 times (7%). The following examples illustrate the most commonly produced errors:

/k/ → [g]	/ˈko.ra/	→	[ˈgo.wa]	'ball'
	/ˈkuː.ku/	→	[ˈguː.gu]	'bird-sound'
	/ˈkaːs.ku/	→	[ˈgaː.gu]	'parrot'
	/kiŋ.ˈkɒŋg/	→	[gʊŋ.ˈgʊŋg]	'King Kong' (name)
			(16 out of 34 words containing k/g errors)	
/t/→[d]	/ˈta.bi/	→	[ˈda.bi]	'you want'
	/tɔ.ˈfːaːħ/	→	[daːħ]	'apples'
	/ta.ˈʕaː.laj/	→	[də.ˈʔaː.li]	'come' + feminine
/f/→[b]	/fi.ˈʧːiː/	→	[bi.ˈtːiː]	'open' + feminine
	/fɒːg/	→	[bɒːk] / [ˈbuːr]	'up'
	/fiː/	→	[viː]	'in'

5.6.2. Prosodic error patterns

5.6.2.1. Coda deletion:

Coda deletion error pattern is when the final consonant in a word is deleted. The frequency of this error pattern showed clear developmental pattern decreasing with age (table 5.45). The youngest group deleted 19% of target coda consonants, while this percentage was reduced down to 5% in the eldest age group.

Coda deletion	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	22	21	23	89	62	49	57	323
No. targets	113	203	235	950	764	923	1,114	4,302
Frequency	19%	10%	10%	9%	8%	5%	5%	8%

Table 5.45: Coda deletion error pattern occurrence and frequency across age groups.

The developmental progression is illustrated in figure 5.42, it shows linear reduction in frequency with age.
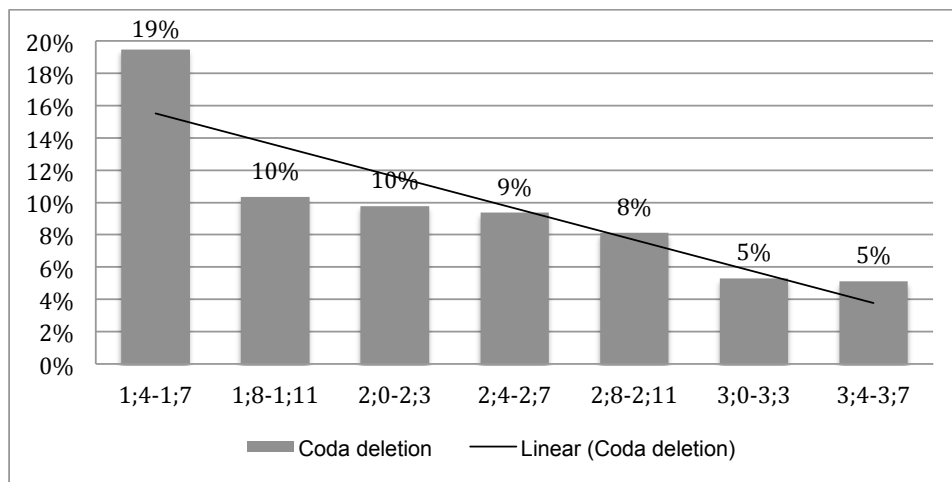
Figure 5.42: Coda deletion error pattern occurrence frequency across age groups.

Children in all age groups produced a total of 323 coda deletion errors. The most frequently deleted consonants are /n/ and /g/ (13% each), followed by /r/, /l/, and /ħ/ (12%, 11%, and 10% respectively). The following examples illustrate most frequently produced coda deletion errors:

/n/ → ∅	/lɒːn/	→	[lɒː]	'colour'	
	/wɛːn/	→	[wɛː]	'where'	
/g/ → ∅	/ʔa.ˈtˤig/	→	[ʔa.ˈtˤi]	'I hit'	
	/fɒːg/	→	[fɒː]	'up'	
/r/ → ∅	/ˈʔəx.ðˤar/	→	[ˈʔeh.ðˤɑ]	'green'	
/l/ → ∅	/ɣə.ˈsːil/	→	[kə.ˈsːeː]	'wash'	
/ħ/ → ∅	/tɔ.ˈfːaːħ/	→	[tɔ.ˈbːəː]	'apples'	

5.6.2.2.   Cluster reduction:

Cluster reduction errors are simplification of consonant, for example, the cluster can be reduced to one member of the consonant cluster, another sound can be substituted for the entire cluster, or one member of the cluster is retained and a sound substitution is made for the other member of the cluster. Features from both members can also be combined so that one sound replaces two other sounds (coalescence).

	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total
No. errors	0	0	4	9	12	4	12	41
No. targets	19	73	11	180	77	117	133	651
Frequency	0%	0%	36%	5%	16%	3%	9%	6%

Table 5.46: Cluster reduction error pattern occurrence and frequency across age groups

Table 5.46 shows the frequency in which this error pattern produced by KA speaking children. The frequency of this error occurrence was found to be highest at 2;0-2;3 age group. Because the speech samples were produced spontaneously, the number of target words was unequal. As seen in table 5.46, the number of target clusters was lowest in 2;0-2;3 age band; this group also produced four out of eleven clusters in error, this resulted in higher frequency percentage. Cluster reduction error patterns were analysed by word position. Table 5.47 shows the frequencies of error occurrence in three words position: word initial, word medial and word final clusters.

Word Initial		Word Medial		Word Final	
Cluster errors	Error frequency[*]	Cluster errors	Error frequency[*]	Cluster errors	Error frequency[*]
dl- → [d]	15%	-dr- → [d]	48%	-lb → [l]	29%
ʃl- → [ʃ]	12%	-dr- → [n]	7%	-lb → [b]	15%
br- → [b]	10%	-ʃw- → [ʃ]	5%	-lb → [p]	12%
dl- → [l]	7%	Less than 2%:		-rf → [f]	12%
Sm- →[m]	5%			-jn → [n]	5%
tw- → [t]	5%	-dr- → [t]; -ʃw- → [s]		-nt → [n]	5%
tr- → [t]	5%			-sk → [s]	5%
Less than 2%: br- → [b] / [l]; kl- → [k]; kw- → [w]; sf- → [f]; sk- → [k]; sm- → [t]; st- → [s]; sˤb- → [b]; sˤɣ- → [z]; ʃf- → [f]; ʃl- → [t]; ʃt- → [t]; ʃw- → [s]; ʃʕ- → [ʃ]; ʃdʒ- → [k]/ [t]				-rd → [r]	5%
				Less than 2%: -lb → [v]; -ld → [d]; -lt → [ð] / [t]; -ltʃ → [t]; -mz → [m]; -mʃ → [ɬ]; -nd → [n]; -nd → [ɬ]; -zg → [k]; -rd → [d]; rd- → [ɹ]; -rs → [j]; -rz → [ʃ]; -ʔb → [β]	
Overall WI error frequency		Overall WM error frequency		Overall WF error frequency	
34%		23%		43%	

[*] Error frequency was calculated for each word position separately to represent the frequency of each consonant cluster type within the named position. WI stands for Word Initial, WM stands for Word Medial, and WF stands for Word Final positions.

Table 5.47: Cluster reduction error pattern occurrence frequency across word positions

Word final consonant clusters were targeted at an earlier age than word-medial and word-initial clusters. However, the overall reduction error frequency was highest in word-final position (43%). Almost one third of word-final cluster reduction errors affect –lb, which was reduced to [l], [b] and [p]:

/ʧalb/ → [ʧɛl]/ [ʧəp]/ [ʦep] 'dog'

The second most frequently reduced cluster was word initial (34%); for example, dl- reduced to [d]:

/dlaːq/ → [laːq] / [daːk] 'sock'

Word medial cluster reduction was least frequent (23%), most frequently affecting -dɾ- cluster, which was reduced to [d]:

/ˈmaː.dɾi/ → [ˈmaː.di] / [ˈmaː.ni] 'I don't know'

The high accuracy of word-medial cluster production was expected as the medial syllable is frequently stressed in KA words (see section 3.5.6 of Chapter 3 for KA stress patterns). From the above examples, it can be seen that almost half of the cluster reduction errors in word-final position were –lb; 29% of –lb realised as [l]; 15% realised as [b]; and 12% realised as [p].

5.6.2.3. Cluster epenthesis:

Cluster epenthesis error pattern is when a vowel is added to a cluster within a word. Table 5.48 shows the frequency in which this error pattern produced by KA speaking children.

Cluster Epenthesis	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	Total CC
No. errors	0	0	0	0	6	2	3	11
No. targets	19	73	11	180	77	117	133	651
Frequency	0%	0%	0%	0%	8%	2%	2%	2%

Table 5.48: Cluster epenthesis error pattern occurrence and frequency across age groups.

Word final clusters are often affected by epenthesis error patterns; –lb was found to be the second most frequently affected (18% of cluster epenthesis errors), for example:

/ʧalb/ →   [ʧa.lib]   'dog'

Word medial cluster epenthesis was found to be affected least frequently, namely –dr- (9% cluster epenthesis errors); for example:

/ˈmaː.dri/   →   [ˈmɒː.də.le]   'I don't know'

Cluster epenthesis mostly affected word initial clusters, namely br- (27% of cluster epenthesis errors); for example:

/bruː.ħi/   →   [bə.ruː.hi]   'alone' + 1st person possessive

/briː.li/   →   [bə.riː.li]   'with my feet'

In the latter example, the initial /b/ represent a bound morpheme that resembles the English preposition *with* or adverb *in*. For example:

(1)   /ba.ʃuːt   ʔil.ku.ra   briː.li/
             I-(will)-kick   the-ball   'with-my-feet' + 1st person possessive

(2)   /bam.sik   ʔil.glaːsˤ   biː.di/
             I-(will)-hold   the-glass   'in-my-hand' + 1st person possessive

In (1) and (2), the pre-fix /b-/ imply the meaning of English adverbs 'with' and 'in'. Thus, /b/+C onset clusters are likely to result from a bound morpheme that adds meaning to the original stem word. This may explain the appearance of this error pattern after the age of 2;8-2;11; which could possibly reflect increase in use of morpho-phonological structures.

5.6.2.4.   Weak syllable deletion:

Weak Syllable Deletion (WSD) errors are when an unstressed syllable of a word is deleted. Table 5.49 shows the frequency in which children in all age groups exhibited this error pattern. It can be seen that its frequency was relatively stable in the first three age groups; it began to decline with age after 2;7.

Age	Target word count	Error count	Frequency
1;4-1;7	1,181	63	5 %
1;8-1;11	1,147	100	9 %
2;0-2;3	1,791	126	7 %
2;4-2;7	4,293	339	8 %
2;8-2;11	4,058	51	1 %
3;0-3;3	3,713	227	6 %
3;4-3;7	4,406	152	3 %
Total	20,589	1,149	6%

Table 5.49: Weak syllable deletion occurrence count, frequency and morphological values across age groups.

The frequency of WSD errors shows great deal of variability across age groups. The overall frequency of WSD appeared to be generally low, however analysis of word length and morphological content of deleted syllables might explain this apparent variability.

Table 5.50 demonstrates the relationship between word length and percentage of deleted syllables with morphological value. Morphological values include all KA bound morphemes such as gender, verb tense markers and possessive pronouns (see examples below). From table 5.50, it can be seen that the percentage of deleted morphological syllable ranges between 20% and 30% for all 2-, 3-, and 4-syllable words. In 5-syllable words, which were rarely used, all deleted syllables were of morphological content.

Age	2-syllables			3-syllables			4-syllables			5-syllables			Total		
	SD	MS	%*	SD	MS	%*	SD	MS	%*	SD	MS	%*	SD	MS	%*
1;4-1;7	62	3	5	1	0	0							63	3	5
1;8-1;11	109	7	6	5	1	20	2	1	50				116	9	8
2;0-2;3	103	3	3	19	2	20	4	0	0				126	5	4
2;4-2;7	178	28	16	141	30	29	19	8	42	1	1	100	338	67	20
2;8-2;11	35	21	60	14	7	50	2	0	0				51	28	55
3;0-3;3	167	51	31	44	9	21	15	5	33	1	1	100	227	64	28
3;4-3;7	100	51	51	42	12	29	10	1	10				152	64	42
Total	754	161	21	266	61	23	52	15	29	2	2	100	1,074	239	22

*Percentage of deleted syllables with morphological value, out of all WSD errors. SD and MS abbreviations used in this for table formatting purposes; Syllable deletion (SD) and Morphological syllable deletion (MS).

Table 5.50: WSD error pattern across age groups: word length and syllable morphological content

From table 5.50, it can be seen that 22% of WSD errors result from deletion of a syllable that holds morphological value. For example:

/ˈnil. ʕab/	→	[ʕaːb]	'we-play'	(present tense, plural)
/ʔa.ˈʕarf/	→	[ʕarf]	'I-know'	(present tense, 1st person possessive)
/ʔa.ˈruːħ/	→	[ruːħ]	'I-go'	(present tense, 1st person possessive)

On the other hand, the other 80% of WSD errors result from deletion of other syllables within the stem, for example:

/ʔu.ˈbuːj/	→	[buːj]	'my-father'
/di.ˈjaː.jə/	→	[di.ˈjaː]	'chicken'
/ˈjə.ɬːə/	→	[jəɬ]	'lets' (do something)
/jə.ˈmːaː/	→	[mːaː]	'mum'
/ˈsa.jːaː.ɾa/	→	[ˈsə.jːaː]	'car'

It is important to note here that most bound morphemes in KA are often unstressed. Interestingly, the overall frequency WSD error patterns decrease with age; however, the number of WSD of morphological syllables increases dramatically after the age of 2;4. This could possibly reflect increase of use of bound morphemes after this and may provide a rationale for variability in the accuracy of productions of longer words as children are challenged with competing morphological and phonological demands (Crystal, 2003).

5.6.3. Overview of error pattern development

Generally, segmental error patterns show a clearer linear change in correlation with age compared to prosodic patterns. De-emphasis is the most frequent error pattern in all age groups (see table 5.51). The frequency of de-emphasis decreased from 75% in the youngest group to 11% by the age of 3;4-2;7. Stopping error patterns is the second most frequent pattern, with 28% in the youngest group declining to 8% by 3;4-3;7. Table 5.51 lists the error patterns that occurred in the sample.

(1) Segmental patterns	1;4-1;7	1;8-1;11	2;0-2;3	2;4-2;7	2;8-2;11	3;0-3;3	3;4-3;7	All groups
Place								
Backing	6%	8%	7%	5%	5%	3%	4%	5%
Fronting	9%	8%	3%	3%	5%	2%	1%	3%
Manner								
De-emphasis	75%	61%	77%	49%	44%	13%	11%	36%
Stopping	28%	30%	17%	14%	14%	7%	8%	13%
De-affrication	0%	0%	0%	6%	14%	6%	4%	7%
Gliding	20%	3%	9%	3%	4%	1%	2%	3%
Lateralization of /r/	18%	46%	19%	23%	22%	5%	21%	19%
Glottal replacement	3%	3%	1%	2%	1%	1%	0%	1%
Spirantization	1%	0%	1%	0%	1%	1%	0%	1%
Nasalization	0%	0%	0%	2%	0%	0%	0%	1%
De-nasalization	1%	2%	1%	1%	1%	0%	1%	1%
Affrication	1%	0%	0%	1%	1%	1%	1%	1%
Glottal replacement	3%	3%	1%	2%	1%	1%	0%	1%
Vocalization	0%	0%	0%	0%	0%	0%	0%	0%
Voicing								
Postvocalic devoicing	0%	0%	4%	11%	6%	3%	1%	4%
Prevocalic voicing	6%	4%	0%	2%	2%	2%	0%	2%
(2) Prosodic patterns								
Affecting syllables:								
Coda deletion	19%	10%	10%	9%	8%	5%	5%	8%
Cluster reduction	0%	0%	36%	5%	16%	3%	9%	6%
Cluster epenthesis	0%	0%	0%	0%	8%	2%	2%	2%
Right-edge cluster reduction	0%	0%	50%	0%	6%	0%	0%	3%
Affecting word shapes:								
Unstressed syllable deletion	5%	9%	7%	8%	1%	6%	3%	6%
Key:	Rare errors <5%		Occasional errors ≥5%		Age appropriate errors ≥10%			

Table 5.51: The development of error patterns across age groups.

Almost all error patterns decrease in frequency with age despite occasional fluctuations in frequency of error occurrence. For example, children in the 1;4-1;7 age group have glided 20% of target /r/, /ɹ/, /ɾ/ and /l/ in their speech; the frequency of gliding error pattern was 9% at 2;0-2;3, while it was 3 % at 1;8-1;11. Despite this fluctuation in the frequency of gliding error pattern, the percentage of its occurrence was reduced down to 2% by the eldest age group (3;4-3;7). Because the calculation of error patterns was based on possible target words, the possibility of frequency fluctuation was expected for several reasons: Firstly, children may avoid difficult targets that are prone to error on realisation. Secondly, variability in number of target words that may exhibit an error pattern may be influenced by the child's lexical knowledge. Finally, environmental and circumstantial factors may play a major role in the frequency of word occurrence. For example, during the recording session, children were provided with a rubber duck and a picture book containing animal pictures

(including a cat). The words /ˈgatˤ.wa/ 'cat' and /ba.ˈtˤ:ə/ 'duck' were among the most frequently produced token words by all children collectively; making up 14% (n=153) and 8% (n=89) out of 1,135 target words respectively. Both words /ba.tˤ:ə/ 'duck' and /ˈgatˤ.wa/ 'cat' contain emphatic consonants that are prone to de-emphasis error pattern. Therefore, if the child names those two objects frequently and incorrectly, this will result in a higher frequency of de-emphasis pattern compared with other patterns.

Chapter 6:

Discussion and Conclusions

6. Chapter Six: Discussion and Conclusions

The purpose of this thesis has been to describe the phonological development patterns of 70 monolingual Kuwaiti Arabic-speaking children aged between 1;4 and 3;7. The children were observed and recorded in spontaneous interactions with a familiar adult. The speech samples were divided into seven groups of three-monthly intervals in order to gain insight of the developmental patterns of the children's phonological systems. Two aspects of speech development were considered: the age of consonant acquisition and the development of error patterns. The study addressed the research questions outlined in Chapter 4, and the comprehensive results were presented in Chapter 5. The findings are discussed in light of two influential aspects of the ambient language which are believed to shape the development of the child's phonological system: frequency of sounds and the sonority index.

The first section of this chapter explores the influence of frequency of occurrence on the development of the KA phonological system and demonstrates the application of the sonority index on KA phonology. The second section illustrates the influence of dialectal variability on phonological acquisition by comparing the rate and order of consonant acquisition in three dialects of Arabic. The third section highlights the differences between Arabic and English phonological development and explores how the study of KA enriches our knowledge regarding the influence of the ambient language. The fourth section discusses universal and language-specific error patterns and sheds light on possible influential factors of the ambient language in the early stages of the development of child phonology. The final section concludes with a summary of the main findings followed by a brief exploration of the theoretical and clinical implications. This chapter also offers suggestions for future research.

6.1. The acquisition of KA phonology

6.1.1. KA phonological development profile

The data derived from the current study showed that children acquiring KA are able to produce over half of KA consonants with 75% accuracy before the age of 3;7. By 3;7, children acquiring KA were able to accurately produce 14 different consonants (out of 37 KA consonants) with over 90% accuracy. An additional 12 consonants were also produced with over 75% accuracy. A summary of the ages of KA consonant acquisition is listed in table 6.1.

Age	Mastery production (>90%)	Acquisition production (75-89%)	Customary production (50-74%)	Not acquired (<50%)
1;4-1;7	/ʔ/	/b, m, n, w/	/t, d, k, ʃ, l/	/p, g, q, r, ɾ, ŋ, f, v, θ, ð, s, z, ʒ, x, ɣ, ħ, h, ʕ, j, ɬ, ʧ, ʤ, ðˤ, tˤ, dˤ, sˤ, zˤ/
1;8-1;11	/ʔ/	/b, t, m, n, j/	/d, k, g, s, ʃ, h, w, l/	/p, q, r, ɾ, ŋ, f, v, θ, ð, z, ʒ, x, ɣ, ħ, ʕ, ɬ, ʧ, ʤ, ðˤ, tˤ, dˤ, sˤ, zˤ/
2;0-2;3	/k, ʔ/	/b, m, n, s, w, j/	/t, d, ħ, h, l/	/p, g, q, ŋ, r, ɾ, f, v, θ, ð, z, ʃ, ʒ, x, ɣ, ʕ, ɬ, ʧ, ʤ, ðˤ, tˤ, dˤ, sˤ, zˤ/
2;4-2;7	/n, ʔ, w/	/b, t, d, k, m, s, h, l/	/g, f, z, x, ħ, ʧ, ʤ, sˤ/	/p, q, ŋ, r, ɾ, v, θ, ð, ʃ, ʒ, ɣ, ʕ, ɬ, ðˤ, tˤ, dˤ, zˤ /
2;8-2;11	/k, m, ʔ/	/b, t, d, n, r, f, h, w, j, l/	/g, s, z, x, ħ, ʕ, ðˤ/	/p, q, ŋ, ɾ, v, θ, ð, ʃ, ʒ, ɣ, ɬ, ʧ, ʤ, tˤ, dˤ, sˤ, zˤ/
3;0-3;3	/b, k, m, ʔ, n, h, w, l/	/t, d, g, ɾ, n, f, s z, ʃ, ħ, j, ʧ, ðˤ, tˤ/	/r, θ, ð, x, ʕ, ɬ, ʤ , sˤ, zˤ/	/p, q, ŋ, v, ʒ, ɣ, dˤ/
3;4-3;7	/p, b, t, d, k, g, ʔ, m, n, f, s, w, l, ɬ/	/r, z, ʃ, x, ħ, ʕ, h, j, ʤ, ʧ, tˤ, sˤ/	/q, ɾ, ɣ, ðˤ/	/ŋ, v, θ, ð, ʒ, dˤ, zˤ/

Table 6.1: the ages of *customary production, mastery,* and *acquisition* of KA consonants

In addition to individual consonants, phonological structures were found to be sensitive to frequency. As for segments, type and token frequencies have been used in earlier research to detemine the functional load of linguistic or phonological units. Hua and Dodd (2000) suggested that phonological saliency (which we referred to as *functional load* in Chapter 1) is a language-specific concept often influenced by a combination of several factors: the status of a component in the syllable structure, the capacity of a component in differentiating lexical information of a syllable, and the number of permissible

choices within a component in the syllable structure. Considering the status of the segment within a syllable and its lexical capacity in KA monosyllable words is important to determine its phonological saliency within the language. This is due to several factors: first, KA monosyllable words are far less frequent than multisyllable words. Second, In KA, there are 30 permissible consonant types in onset position, which result in lower phonological value according to Hua and Dodd's (2000) calculation (i.e. as the number of permissible choices within a syllable component increases, the value of its phonological saliency decreases). In KA, the functional load of word-initial /b/, as demonstrated in the minimal pairs /ba:b/-/ɣa:b/ 'door'-' he-disappeared' and /ba:g/-/ðˤa:g/ 'he-stole'-'he-tasted', plays a vital role in differentiating lexical information. As such, the three components of Hua and Dodd's criteria could possibly predict the value of phonological saliency of KA segments in simple word structures. However, the role of functional load (according to Hua and Dodd's definition) needs to be further explored in languages such as Arabic, where multisyllabic words occur more frequently than monosyllabic ones. Since the lexical contrast that can occur in KA multisyllabic words is unknown, this discussion will only focus on the frequency and sonority index as potential influencing factors on the development of KA phonology.

6.1.2. Frequency effects in the development of KA consonants

The frequency of a particular language element, such as a segment or a segmental contrast, is believed to influence the order of emergence and the accuracy of consonant production in the speech of children acquiring different languages (e.g., English and Cantonese: Stokes & Surendran , 2005; English: Zamuner et al., 2005). However, the role of type and token frequency for the order in which consonants are acquired is not equivocally supported (see section 1.4.3 of Chapter 1). Some researchers propose that consonant production accuracy is sensitive to type frequency (Pey et al., 1987; Zamuner , 2004); while others suggest that token frequency has a greater influence on the acquisition of various phonological units (Stokes & Surendran, 2005).

The notion of relative frequency is often referred to in the computation of the *functional load* of a particular linguistic unit, such as segment or segmental contrast. Earlier research found that children appear to be sensitive to the frequency of patterns in the ambient language when building and organizing their phonological knowledge (Amayreh & Dyson, 2000; Stites, Demuth, & Kirk, 2004; Yoneyama, Beckman, & Edwards, 2003; Zamuner et al., 2005). For instance, Zamuner et al. (2005) examined the frequency distribution of codas in the speech of 59 English-speaking children aged between 0;11 and 2;1; they found that the relative frequency of codas in child speech was significantly correlated with the relative frequency of those that occur in child-directed speech. In other words, consonants that are frequently produced by adults are produced frequently in children early lexical stage. Likewise, Pye et al. (1987) found significant correlation between the order of acquisition and the type frequency of occurrence of word-initial consonants in five Quiché-speaking children (aged between 1;7-3;0) and fifteen English-speaking children (aged between 1;5-2;2).

In the current study, the frequency of occurrence was explored on three levels: (a) the overall frequency of consonantal manner groups in all environments; (b) context specific frequency of consonantal groups in word initial, medial and final positions; (c) context specific frequency of all target consonants in onset position of monosyllabic words. For each frequency calculation, the influence of both type and token frequencies are explored and the frequency effect on consonant production accuracy and the development of error patterns are examined in detail.

   a. *The overall frequency of consonant groups in all environments:*
Consonant production accuracy was explored for consonantal manner groups and individuals to determine common trends in the influence of frequency of occurrence on the consonant production mastery. The overall type and token frequency of KA consonant occurrence in child speech were similar, except for the two most frequently used consonant groups: stops and fricatives. According to type frequency, stops were most frequently targeted and affricates the least, resulting in the following sequence (high to low):

Stops > Fricatives > Nasals > Approximants and Laterals > Tap/Trill > Emphatics > Affricates

However, token frequency showed fricatives as being the most frequently targeted consonants followed by stops, in the following sequence:

Fricatives > Stops > Nasals > Approximants and Laterals > Tap/Trill > Emphatics > Affricates

The production accuracy of KA consonants was examined to explore the influence of type and token on the order of consonant acquisition. Based on token frequency, the fricatives were expected to be acquired before stops; however, findings from the current study did not support such a prediction. For instance, all KA stops were produced with 90% accuracy between the ages of 3;4-3;7, except the uvular stop /q/ which was produced with 59% accuracy.

According to Brown[2] (1988), the articulatory similarity of segments should also be taken into account. Brown proposed that consonants differing in only one articulatory feature (e.g. voicing: /t/-/d/) are more likely to be confused than consonants differing in two or more features (e.g. place and manner: /s/-/b/). For example, two out of eleven KA fricatives were produced with 90% accuracy by the age of 3;4-3;7, namely /s/ and /f/, which were the earliest acquired fricatives that only differ in place of articulation. On the other hand, the KA /x/ and /k/ share the same place of articulation but are produced with different manners. /k/ was mastered (>90% accuracy) between the ages of 2;0-2;3, while the fricative /x/ only reached customary production (>50% accuracy) between the ages of 3;4-3;7. Similarly, the consonant pair /g/-/ɣ/ is another example of the early acquisition of stops compared to fricatives. KA speaking children produced /g/ and /ɣ/ with 94% and 70% accuracy respectively between the ages of 3;4-3;7. In those examples, it can be seen that Brown's accounts applies to place feature but not to manner. Therefore, other influential factors can also play a role in predicting order of consonant acquisition such as frequency and sonority

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[2] Note that the original study was looking at adult L2 learning rather than child acquisition.

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The production accuracy data showed that type frequency is not specific enough to predict the order of consonant acquisition for KA speaking children. For example, according to type frequency, the voiceless alveolar stop /t/ was produced in high frequency (6%), thus it is expected to be acquired before /k/, which was less frequently targeted (4%). However, the production accuracy analysis showed that /k/ was mastered (90% accuracy between the ages of 2;0-2;3) earlier than /t/ (93% accuracy between the ages of 3;4-3;7). On the other hand, the frequency of the voiced dental fricative /ð/ showed a larger role for type over token frequency. According to token frequency, /ð/ was the seventh most frequently targeted (6% of tokens) consonant in KA child speech; whereas according to type frequency, it was one of the least frequently targeted consonants (<1% of types). The production accuracy of this particular consonant only reached a maximum of 63% (customary production) between the ages of 3;0-3;3. If token frequency prediction was to be accounted for in predicting consonant acquisition, then /ð/ should be one of the earliest consonants acquired by KA speaking children. However, this finding is more likely to support the prediction of type frequency rather than token frequency (c.f., Zamuner, 2004).

There are a number of possible explanations for these variable findings. First, both type and token frequencies were derived from the child's target words in spontaneous speech. If the child avoids 'difficult' sounds (i.e. more complex), the target words will be limited to the child's favourite or more plausible sounds, which are likely to be produced more accurately. Second, type frequency may not represent KA consonants that occur in adult speech due to the child's rather limited lexical knowledge. Our data shows that all high frequency consonants (both type and token) were acquired at an early stage. However, the difference between type frequency in adult and child speech may be reflected in the order of acquisition. For example, if consonant X occurs in high frequency in the child's speech, but occurs in low frequency in the adult's speech, consonant X is acquired earlier than expected if the prediction was based on its frequency in the adult's speech. Third, word length and structural differences may also influence the production of consonant accuracy in some word positions. For instance, consonants occurring in prevocalic position may be more salient than

those occurring in postvocalic position; hence the former are better perceived, and tend to be produced more accurately (Vihman & de Boysson-Bardies, 1994). Therefore, in order to limit the variable effects of structural distribution on frequency (e.g., word length and stress), the accuracy of consonant production was examined in three word positions (below) and in onset position of simple monosyllable words (to follow).

b. *Context specific frequency of consonant groups in word initial, medial and final positions:*

The frequencies of groups of consonants were calculated in all three different word positions (table 6.2). Generally, the association between occurrence frequencies of consonant groups in different word positions tend not to be in agreement with the production accuracy. For instance: in word initial position, stops were most frequently used followed by fricatives and nasals, however, in this position, nasals and laterals were the most accurately produced consonants followed by stops and approximants. In word medial position, fricatives were the most frequently used consonants followed by stops and nasals; but laterals were produced most accurately in medial position followed by nasals and stops. Likewise, in word final position, the most frequently occurring consonants are stops, followed by nasals and fricatives; although nasals and stops were produced with high accuracy, approximants were the most accurate consonants produced in word final position.

High ⟵			Frequency			⟶	Low
Word Initial							
Frequency	Stops	Fricative	Nasals	Approx.	Emphatic	Laterals	Affricates	Trill/Tap
Production	Nasals	Stops	Laterals	Approx.	Fricative	Trill/Tap	Affricates	Emphatic
PCC	90%	88%	83%	83%	70%	51%	46%	40%
Word Medial							
Frequency	Fricative	Stops	Nasals	Lateral	Trill/Tap	Approx.	Emphatics	Affricates
Production	Laterals	Nasals	Stops	Approx.	Fricative	Fricative	Trill/Tap	Emphatic
PCC	88%	87%	85%	85%	60%	59%	55%	52%
Word Final							
Frequency	Stops	Nasals	Fricative	Trill/Tap	Laterals	Approx.	Affricates	Emphatic
Production	Approx.	Nasals	Stops	Laterals	Fricative	Affricate	Emphatic	Tap/Trill
PCC	92%	87%	86%	86%	79%	75%	56%	52%

Table 6.2: KA consonant occurrence frequency and production accuracy in three word positions

The results show reduced effects of frequency on production accuracy. The frequency of stop occurrence was found to be highest in word initial positions; where it was produced most accurately compared to other word positions. For instance, two out of ten stops were produced with an accuracy of 90% or more in word initial position (namely /b/ and /t/). Likewise, the velar stop /k/ occurred most frequently in word medial position, where it was produced most accurately (94%).

Nevertheless, nasals were targeted more frequently in prevocalic positions. While they mainly occurred in word medial position, they were produced most accurately in word final position. For example, the alveolar /n/ occurred more frequently in word medial position, but was produced with higher accuracy in word final position. On the other hand, the bilabial /m/ occurred more frequently in word initial position, where it was produced most accurately. The tap and trill were used least frequently in word initial position, however, they were produced least accurately in this position compared to word medial and final positions. Likewise, fricatives were used more frequently in word initial and medial positions, but they were produced more accurately in word final position. In word initial position, only two out of ten fricatives (namely, /f/ and /s/) met the customary production accuracy criteria (>75%); whereas word finally, four out of ten met the customary production accuracy (f, s, z, ħ, h/). Likewise, laterals

occurred more frequently in word medial and word final than in word initial position; but they were produced in comparable accuracy in all three positions, ranging between 86% and 88%.

Consonants that occur in very low frequency are less sensitive to the frequency effect on production accuracy. For example, affricate occurrence is very low in all positions (maximum 4% in word initial and final positions), yet production accuracy met the acquisition threshold, reaching 75% in word final position. Similarly, approximants are targeted more frequently in word initial position, but the production accuracy was at its highest in word final position.

The lack of consistent agreement between context-specific frequency and production mastery may reflect the complexity of Arabic words, particularly as they are multisyllabic in most cases. Studies have shown that the length of the word in which a consonant is embedded may affect its production accuracy. It has been noted that there is an inverse relationship between the length of the stressed syllables and the number of syllables in a word (Ladefoged, 1993). For instance, Kirk (2008) found that coda consonants in monosyllabic words are more acoustically salient than coda consonants in disyllables; the former are considered to be more salient due to their longer duration. Disyllabic words predominate KA word types and tokens (52% and 60% respectively; see tables 5.3 and 5.5 in Chapter 5). This explains the lack of consistent effects of context specific frequency and the accuracy of consonant production. Thus, the mere influence of frequency may not be adequate to influence the accuracy of consonant production. Also, other possible influencing factors such as sonority ought not to be overlooked (see section 6.1.6 below).

   c. Context specific frequency of target consonants in onset position of monosyllabic words:

The result of this analysis was not introduced in the results chapter. This specific analysis was conducted to support the argument of this discussion. At the segmental level, we carried out a detailed analysis of the onset consonants in monosyllabic words to avoid the possible effects of the suprasegmental factors such as stress and word length. The frequency of onset consonants in

monosyllabic KA words was examined against the overall production accuracy in onset environments. Figure 6.1 illustrates type and token frequencies of each onset consonant in monosyllabic target words.
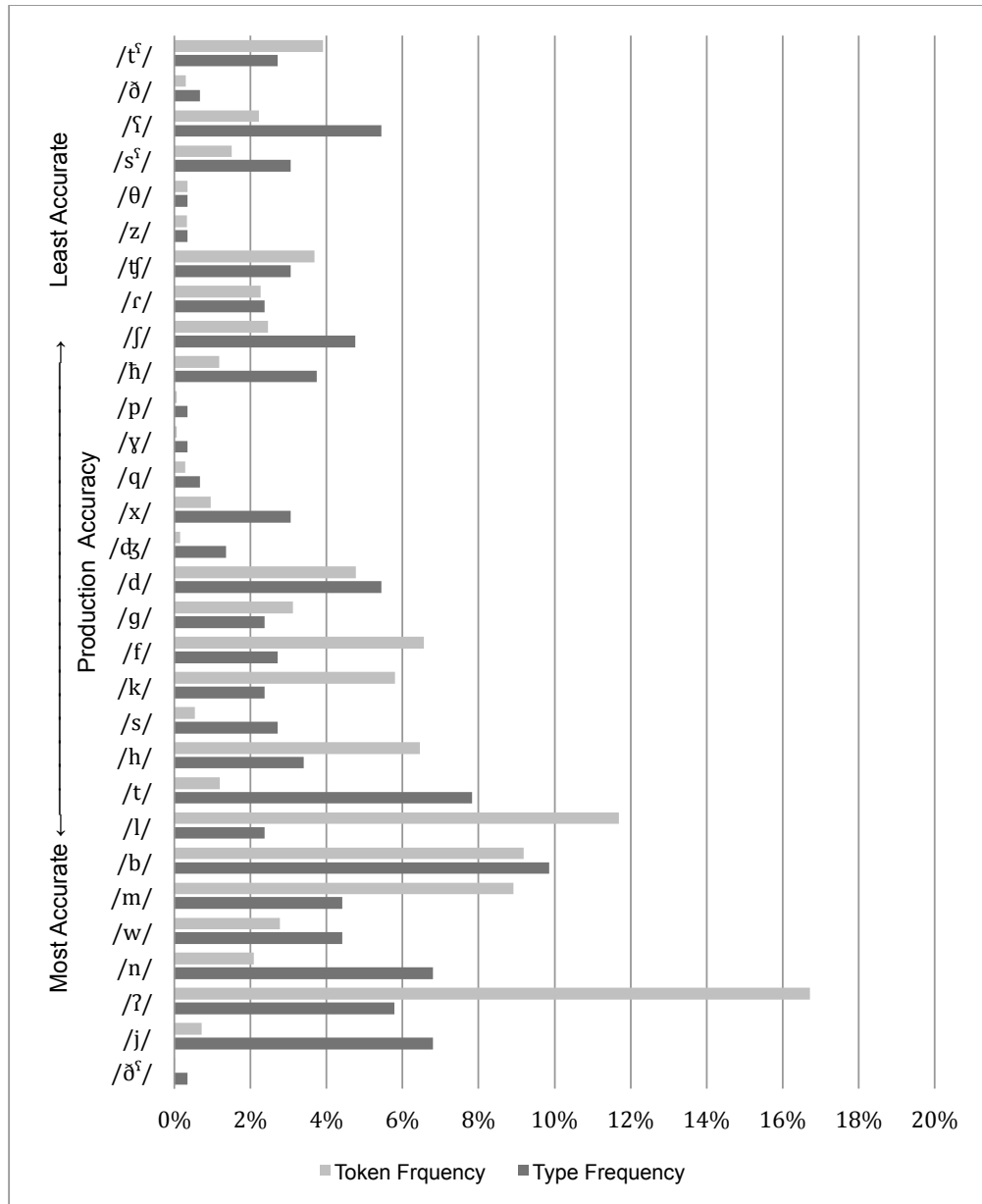
Figure 6.1: Frequency and production accuracy of onsets in target KA monosyllabic words

The consonants are rank ordered according to production accuracy; the consonants produced with the highest accuracy appear on the bottom of the

chart while the least accurately produced consonants appear on the top of the chart. Figure 6.1 shows that, generally, less frequent consonants tend to be produced less accurately (e.g., tˤ, ð, θ, z). However, some consonants do show a larger discrepancy between frequency (type and token) and production accuracy. For instance, the children showed a preference for some consonants, such as /l/, /m/, /ʔ/, /h/, /k/, and /f/, which resulted in higher token frequency, while type frequency remained relatively low. On the other hand, they showed less preference for consonants such as /j/, /n/, /t/, /x/, /ʃ/, and /ʕ/, which have relatively higher type frequencies but lower token frequencies. In other words, children were selective about which consonants they frequently used in spontaneous speech.

The children's apparent selectivity could possibly reflect personal preferences (e.g. affection to specific named objects or people) or the articulatory or perceptual strengths of the individual child within the relatively tight neurophysiological constraints of the developing vocal tract (Hua & Dodd, 2000). For example, the dental emphatic /ðˤ/ was produced accurately by one child, only once in the word /ðˤɑb/ 'lizard'. In this specific case, we learnt that the family had a pet lizard.

In terms of perceptual strengths, the palatal approximant /j/ was produced with relatively high accuracy and was targeted frequently by KA chidlren (i.e. high token frequency); however, type frequency does not support its early accurate production. The role of perceptual properties of this consonant could explain its accurate production. The palatal approximant [j] is phonetically similar to the vowel [i], hence it is often described as a semivowel alongside with [w], as they both share several vowel acoustic properties (Yavaş, 1998);. Accordingly, they are considered more acoustically prominent and are expected to be acquired earlier than other consonants (e.g. fricatives, laterals, and stops).

Consonants with the least articulatory complexity tend to be the preferred ones. Ease of articulation could possibly justify children's selectivity in the production of /ʔ/ and /h/ despite their relative lower type frequencies. For instance, KA speaking children show a tendency to use the glottal stop /ʔ/ in word onset,

while its type frequency is relatively low. The production of /ʔ/ requires complete closure at the glottis with no other articulatory gestures in the oral cavity. Consequently, it is considered as one of the least complex consonants alongside the glottal fricative /h/, which only differ in airflow control despite its posterior place of articulation.

Another example is the lateral /l/ in monosyllable onset position; its type frequency is 2.4% (5 out of 2,804 types) whereas its token frequency is 11.7% (536 out of 4,584 tokens). A detailed examination of tokens targeted by children showed frequent use of the following five lexical items, which are the following: /laʔ/ - /laː/ 'no', /leːʃ/ 'why', /leːt/' 'light', /lɒːn/ 'colour' and /leːn/ 'until', which were monosyllable words with /l/ onset. The first two words 'no' and 'why' were used frequently by parents and children; the former is used in negation and the latter is an interrogative word. Both words occur highly frequently in child directed speech in English (Cameron-Faulkner, Lieven, & Tomasello, 2003); this could also apply to KA speaking mothers. To date, child directed speech has not been examined in Arabic. Other influential factors could possibly shape the development of children's phonological repertoire (e.g., frequency of occurrence, stress patterns, sonority and acoustic noticeability). The influence of the adult language is expected to increase as the child develops language competence. This could only be explored by careful examination of the developmental patterns of individual consonants and their sequential acquisition. The following section will focus on the results of production accuracy and error patterns in onset position.

Table 6.3 lists all onset consonants that were used spontaneously by KA-speaking children. The consonants are rank ordered according to production accuracy, with the most accurately produced consonants listed at the top. Results show that the consonants were produced with highest accuracy are the ones that occur most frequently in KA. For instance, all consonants produced with 90% accuracy or more (e.g. j, ʔ, n, m, w, b. l. t. h/) were found to occur with high frequency compared to consonants that were produced less accurately (e.g. /tˤ, ð, ʕ, sˤ, θ, z, ʧ/). However, there were some 'preferred' consonants that

occurred less frequently but were produced with high accuracy, such as /ðˤ/ and /ʔ/ (discussed above).

	Onset Consonant	Type Frequency	Token Frequency	PCC
	/ðˤ/*	0.3%	0.0%	100%
	/j/	6.8%	0.7%	100%
	/ʔ/	5.8%	16.7%	99%
	/n/	6.8%	2.1%	98%
	/w/	4.4%	2.8%	97%
	/m/	4.4%	8.9%	97%
	/b/	9.9%	9.2%	96%
	/l/	2.4%	11.7%	94%
	/t/	7.8%	1.2%	93%
	/h/	3.4%	6.5%	92%
	/s/	2.7%	0.5%	84%
	/k/	2.4%	5.8%	83%
	/f/	2.7%	6.6%	82%
	/g/	2.4%	3.1%	76%
	/d/	5.4%	4.8%	75%
	/dʒ/	1.4%	0.2%	71%
	/x/	3.1%	1.0%	70%
	/q/	0.7%	0.3%	69%
	/ɣ/	0.3%	0.1%	67%
	/p/	0.3%	0.1%	67%
	/ħ/	3.7%	1.2%	63%
	/ʃ/	4.8%	2.5%	59%
	/r/	2.4%	2.3%	58%
	/tʃ/	3.1%	3.7%	56%
	/z/	0.3%	0.3%	53%
	/θ/	0.3%	0.3%	53%
	/sˤ/	3.1%	1.5%	52%
	/ʕ/	5.4%	2.2%	44%
	/ð/	0.7%	0.3%	29%
	/tˤ/	2.7%	3.9%	20%
	Total	294	4584	

*Consonant used once only by one child only in the sample.

Table 6.3: Onset consonant in monosyllabic words

An error pattern analysis of onset tokens in monosyllabic words is listed in table 6.4 below. Four of the most frequent patterns are: de-emphasis (64%), de-affrication (32%), /r/ lateralization (28%) and stopping (11%).

Error pattern	Target tokens	Error count	Error frequency
De-emphasis	249	159	64%
De-affrication	176	57	32%
Lateralization of /r/	104	29	28%
Stopping	854	91	11%
Devoicing	2011	66	3%
Fronting	2511	58	2%
Gliding	104	1	1%
Affrication	1120	3	0%
Voicing	1339	1	0%

Table 6.4: The frequency of error patterns affecting onset consonants in monosyllabic words.

As emphatic consonants are among the least frequent consonants in onset position (with the exception of /ðˤ/), they are more likely to be produced in error. Similarly, affricates and fricatives occur with relatively low frequency, resulting in higher de-affrication and stopping error patterns. However, some rare errors were also found to occur; for example, a single child (aged between 1;4-1;7) produced all velar stops /g/ as [l] resulting in almost 13% of lateralization errors. It is possible here that the child used the more 'accessible' or 'preferred' sound [l] to replace the less 'preferred' consonant; especially as the child also realised the tap /r/ as [l].

In general, token frequency shows a greater tendency to influence the production accuracy than type frequency. Similar findings have been reported for children acquiring English. Zamuner (2004) found that the acquisition of English consonants is sensitive to token frequency, which is more likely to predict the order of consonant acquisition than type frequency. Zamuner compiled these results from four databases of child directed speech. However, in the absence of an Arabic corpora database, the current study derived type and token frequencies from the children's own speech to provide the closest approximation to children's input. Despite the methodological differences, the findings are similar. Token frequency could predict the order of consonant acquisition in child speech in simple syllable structures (monosyllabic words); however, this may not be the case for more complex word structures of KA (see section 3.5.5 of Chapter 3).

In the current study, the frequency of occurrence was computed according to the child's own target words, which is more likely to reflect the child's phonological and lexical repertoire. Thus, the token frequency of several KA consonants was found to be remarkably higher than type frequency. This supports Hua and Dodd's (2000) claim of that the sounds frequently used by children may not reflect all the sounds used by adults speaking the same language. Vihman (2013) also suggested that within languages, mothers are remarkably similar in their sampling of the adult phonetic categories and patterns, whereas the children differ (p.167; see also DePaolis, Vihman, & Nakai, 2013; Majorano, Vihman, & DePaolis, 2013). It is important to note here that the current study did not examine the frequency of occurrence in the adults' speech. Thus, this evidence could possibly reflect child selectivity in consonant use, where the child is likely to choose words to suit his or her articulatory capabilities. This 'preference' was also reflected in the development of error patterns; for instance, common error patterns were found to affect the least frequently used tokens (e.g. emphatics, fricatives and affricates).

The non-target-like phonological patterns can also be due to the child's developing grammar (Abdalla, Aljenaie, Mahfoudhi, Bavin, and Naigles, 2012), which needs to be looked at in conjunction with sound acquisition especially in a language with rich bound morphology like Arabic. Children learning KA were found to use different grammar compared to the adults' target grammar. In casual KA speech, it is often acceptable for a child to omit a bound morpheme such as a plural suffix or gender marker. For example, a child may use 2nd person masculine singular possessive in an utterance that is directed to a female adult (e.g., /qa.lə.mitʃ/ 'your-pen-2[nd]person feminine singular possessive') → [qa.lə.mik] 'your-pen-2[nd]person-masculine-possesive'), and still be fully intelligible to the adult listener. This error is almost always acceptable in child speech, while it may severely compromise mutual intelligibility in adult conversation. Unlike Germanic languages, where object pronouns are freestanding, Arabic is an agglutinative language, in which all direct and indirect object pronouns are affixed to the root lexeme. Data from the current study show that almost one third of deleted weak syllables hold a morphological value, either to mark verb tense or a pronoun (see table 5.50 in Chapter 5). In

KA, bound morphemes (e.g. clitic pronouns) are commonly placed at the end of the word (Shaalan, 2010). In such position they are less salient perceptually, and are less auditorily prominent; therefore, those bound morphemes are prone to deletion.

In sum, the general discrepancy between the acquisition of KA consonants and their frequency could be due to many factors. First, the current study did not limit the analysis to monosyllabic words since disyllabic words are more frequently used in Arabic. Earlier research measured the frequency of occurrence in simple monosyllable words where minimal pairs are more likely to occur. Using this method for complex Arabic words may not be applicable. Second, the nature of the relational analysis used in the current study differs from earlier research in the area of phonological development. The analysis in this study used the child's own targets as a cohort to perform the relational analysis; this led to a less clear-cut difference the effect of types and tokens on accuracy, with both potentially reflecting child preference. Third, the current study did not perform a specialized statistical analysis to support the research findings (or reject them).

6.1.3. Frequency effects on the development of KA word shapes

Phonological structures have been found to be sensitive to frequency in child speech development (Demuth, 2000, 2001; C. Levelt et al., 2000; Roark & Demuth, 2000). The findings of the current study have shown that the most frequently targeted word shape was CVV.CV, with overall token frequency of 19% in all age groups; its type frequency, however, did not exceed 5%. A closer analysis showed extensive use of the following Arabic pronouns /ˈhaː.ðə/ 'this'+masculine and /ˈhaː.ði/ 'this'+feminine, which was then reflected in token frequency. Note that those pronouns made up 51% of all CVV.CV word shapes (1,973 out of 3,646 tokens), however, even when the pronouns were excluded from the token frequency calculations, the CVV.CV word shape remained the most frequently used shape amongst all other tokens (10%). It is important to note here that the exclusion of those pronouns is unrealistic and masks the natural speech production between children and their parents; nonetheless, this

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exclusion was carried out in an attempt to illustrate the 'true' rank order of word shapes.

The number of words targeted spontaneously by KA speaking children increased dramatically between the two age groups 2;0-2;3 and 2;4-2;7. At this point, the number of target words almost doubled, and longer words of four syllables began to appear in child speech with increased variability in target word shapes. Children were found to use a larger variety of word shapes (types) increasing in length and complexity with age. The total number of different word shapes was 35 at 1;4-1;7, whereas at 3;4-3;7, children were found to use 159 different word shapes in their speech. Between the ages of 2;0-2;3 and 2;4-2;7, the number of types also showed a dramatic incline from 51 to 140 different word shapes. At this age, the number of target tokens was found to double, from 1,743 to 4,184. Also, at this age, cluster reduction and weak syllable deletion error patterns decreased from 36% to 5% and 10% to 1% respectively. These observations reflect marked lexical growth, accompanied with the emergence of complex morphological elements around the age of 2;6. The interaction between phonology and morphology was never investigated for Arabic speakers; however, it was documented for children acquiring other languages (Bernhardt & Stemberger, 1998, 2002).

6.1.4. Consonant occurrence frequency effects on the development of error patterns produced by KA-speaking children

The influence of frequency of occurrence on the development of error patterns has received less attention in the literature, although it is often used as one of several parameters to quantify the segmental markedness of a phonological unit (c.f. Battistella, 1990; Greenberg, 2005; Stites et al., 2004; Trubetzkoy, 1969). It has been assumed that less marked segments occur more frequently cross-linguistically and are less phonetically stable (e.g. Calabrese, 1995; Rice, 1999). However, the markedness concept is generally criticized for making predictions about universal patterns but remaining silent about what is predicted at the language-specific level (Hume, 2011). In order to explore the influence of frequency on the development of error patterns, examples of the three most

common segmental error patterns produced by KA-speaking will be discussed here: de-emphasis, lateralization of /r/, and stopping.

The most common error patterns produced by KA speaking children relates to the production of emphatics, which are the least frequent consonant group. The emphatic consonants occur in extremely low frequency in KA children's speech (type and token, <1%); thus, they are prone to erroneous production whereby the secondary articulation (pharyngealisation) is often omitted. This low occurrence frequency was reflected in the de-emphasis error pattern. The youngest age group (1;4-1;7) de-emphasised 75% of all target emphatic consonants; whereas the eldest group (3;4-3;7) de-emphasised 11% of all possible occurrences. Similar findings have been reported for Jordanian Arabic speaking children. Amayreh and Dyson's (1998) study suggested that the articulatory complexity of emphatic consonants results in a higher rate of production errors. In addition to the influence of the articulatory complexity, findings from the current study support the frequency effect on the development of emphatics as well as other consonants, such as /r/, which is discussed below.

Lateralization of /r/ is the second most commonly produced error pattern in the speech of KA children. Although /l/ and /r/ are preferred consonants cross-linguistically (in adults speech) (Zamuner, 2004); both tap and trill /r/s are among the least frequently targeted consonants by KA children with type and token frequencies of less than 1%. Moreover, /r/ and /ɾ/ were never produced with accuracy higher than 78% by any of the age groups. By age 3;7, the maximum production accuracy for /r/ and /ɾ/ was 76% and 78% respectively.

Stopping is the third most common error pattern produced by KA speaking children. However, the frequency analysis showed that fricatives are the most frequently produced consonants in KA according to type frequency, and second most frequently used according to token frequency. The youngest age group (1;4-1;7) realised 28% of all target fricatives and affricates as stops; this pattern decreased to 7% between the ages of 3;0-3;3. One possible explanation could be that children are more sensitive to articulatory complexity than frequency

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after the age of 3;0. Stokes and Surendran (2005) found that children's production before the age of 2;0 is more likely to be influenced by input frequency and functional load; while older children are more sensitive to articulatory complexity. In KA, the stopping error pattern reduce in frequency by 50% between the two age groups 2;8-2;11 (14%) and 3;0-3;3 (7%). This difference in stopping error frequency could possibly result from a change in the child's sensitivity to various influential factors such as frequency of occurrence and articulatory complexity.

A closer examination of the frequency of consonant types shows a different picture. In KA, the most frequently occurring stopping error was /ð/ being realised as [d]; this accounted for 48% of all stopping errors. The type frequency of /ð/ was found to be 0.6%, whereas its token frequency was 5.6%. In this case, type frequency is more likely to influence production accuracy than token frequency.

Coda deletion is the fourth most commonly exhibited error pattern by KA speaking children; it accounts for 8% of all errors patterns. The most frequently deleted consonants are /n/ and /g/ (13% each). The nasal /n/ occurs most frequently in word medial position (token frequency 42%) where it is most accurately produced (PCC 83%); on the other hand, only 13% of /n/ targets were accurately produced in word final position (PCC 88%). Similarly, the velar stop /g/ was found to occur least frequently in word final position (token frequency 13%), where it was least accurately produced (PCC 46%). The two /n/ and /g/ examples provide contradicting evidence of the frequency effect on the development of error patterns.

In summary, two of the most frequent error patterns, de-emphasis and stopping, show contradicting evidence for the role of frequency in predicting the course of error development in KA; whereas the development of coda deletion patterns supports the role of frequency. This variability is likely to reflect the influence of additional factors that play a role in shaping the development of KA error patterns, such as articulatory complexity, phonological saliency or functional load.

6.1.5. *The influence of the sonority on the development of KA phonology*

This section revisits the concept of sonority, which was discussed in the literature review (section 1.4.2 of Chapter 1) and provides a brief overview of the sonority index and its application to the development of KA consonants.

Although universal constraints on perception have not been studied as thoroughly as constraints on production, there is some evidence that perceptual constraints also influence the order of the acquisition of consonants. The sonority index of phonological saliency accounts for both perceptual and articulatory parameters. Yavaş (1998) suggested that the more sonorous a sound is, the easier it is to be perceived and acquired. This index is based on the degree of oral cavity opening and voicing contrasts. The oral cavity opening determines the sound's sonority value; the more open the articulation of the sounds, the greater its sonority level. Voicing adds extra sonority value when the opening is matched. In English, /s/ is produced with 75% accuracy by the age of 4;0, while /θ/ is not produced accurately until about the age of 5;9 (Smit et al., 1990). This could be due to differences in perceptual saliency between the two fricatives that determine the order of acquisition (Edwards & Beckman, 2008). That is, the 'strong' sibilant fricatives, such as /s/, are acquired earlier than 'weak' non-sibilant fricatives, such as /θ/. Sibilant fricatives are believed to be easier to perceive than non-sibilant fricatives because the place of articulation can be identified by the fricative noise alone for sibilant fricatives, while fricative noise and the CV transition are needed to identify place of articulation for non-sibilant fricatives (Jongman, Wayland, & Wong, 2000).

According to the sonority index, the proposed prediction of KA consonant acquisition is expected to proceed in the following order ('>' means before):

Glides (/j, w/) > Liquids (/l/) > Nasals > Fricatives > Affricates > Stops

However, the application of the sonority index to Arabic consonants is restricted. For example, findings of the current study show that KA-speaking children acquire stops before fricatives and nasals, whereas the opposite order

of acquisition is expected according to the sonority index. Moreover, the sonority index does not account for secondary articulations, such as pharyngealization, that occur in Arabic emphatic consonants. However, emphatic consonants could possibly be placed with their corresponding manner of articulation. For example, /tˤ/ falls into the stops category and /ðˤ/ is placed with fricatives. Similarly, the production of both /h/ & /ʔ/ require minimal oral articulatory movements; while their production involves glottal constriction to some degree, they lack movement of oral articulators. The /h/ fricative requires wide mouth opening, but lacks voicing; therefore, it may not be as sonorous as other fricatives such as /ɣ/. The latter requires the same mouth opening in addition to voicing and articulatory movement at the velum, which in turn increases the sonority value of /ɣ/ compared to /h/. However, the /h/ was acquired earlier than /ɣ/ despite its lower sonority. Additionally, the difference between Arabic and English /r/ consonants could stand against the notion of universality of the sonority index for consonants. The English /r/ may fall into the glide category; however, as the Arabic trills and taps often involve some degree of alveolar contact it may fit into the stop category. Nonetheless, both Arabic and English /r/s are acquired late regardless of sonority, and both involve complex articulatory gestures.

Despite the fact that the sonority index (Yavaş, 1998) does not accommodate all Arabic consonants, the findings of the current study show partial support for its prediction of the order of consonant acquisition. For instance, glides and liquids were acquired before fricatives and nasals. KA-speaking children were able to produce /j/ with 77% accuracy (i.e. customary production) as early as 1;8-2;0; (although /j/ was not produced with 90% between the ages of 3;4-3;7). Similarly, the youngest group (1;4-1;7) produced /w/ with 79% accuracy; and was mastered a year later between the ages of 2;4-2;7 (90%); On the other hand, none of the fricatives was mastered until the age of 3;0. However, if stops are least salient and are expected to be acquired after glides and liquids, then the early accurate production of /b/ compared with /l/ in KA contradicts this prediction. That is, /b/ was acquired with 83% accuracy at 1;4-1;7, while /l/ reached an accuracy of 87% at 2;4-2;7. Similar findings were also reported in

earlier studies of Arabic phonological development (e.g. Ammar & Morsi 2006; Amayreh & Dyson, 2000; Ayyad, 2011).

6.1.6. Sonority and frequency conflict in the development of KA consonants

According to the sonority index, /t/ is less salient than /k/. In onset position of monosyllabic KA words, the token frequency for /t/ and /k/ are 1.2% and 5.8% respectively; however, the contrary is found in type frequency. Type frequency of /t/ was considerably higher than that of /k/ (7.8% and 2.4% respectively). Based on the /t/-/k/ example, it is possible to posit that phonological saliency is driven by type rather than token frequency. The high saliency of /k/ compared to /t/ could possibly result in higher acoustic noticeability which results in earlier acquisition despite its posterior place of articulation. This particular finding suggests that the child selectively chooses sounds to produce based on frequent patterns in the input that are most likely to capture their attention; consequently, they are acquired early regardless of the place of articulation. However, type frequency is not always sensitive to saliency effects. For example, nasals are considered more salient than stops; but our data show that both /m/ and /b/ were targeted in a comparable token frequency (9-10% range); however, type frequency of /b/ was higher than /m/ (9.9% and 4.4% respectively). This apparent conflict between sonority and frequency in the development of KA consonants provides an ideal testing ground for determining learnability preferences. On one hand, if learners are sensitive to *sonority*, they should acquire more sonorant consonants before stops in onset positions. On the other hand, if learners are sensitive to *frequency,* they are expected to acquire stop onsets before more sonorant onsets.

In summary, children showed apparent selectivity that may reflect personal preference (e.g. nickname word shape), or articulatory (e.g., avoiding complex emphatic consonants) or perceptual strengths (e.g., acquiring trill /r/ before tap as it occurs in a geminate context). These factors here must have a bearing on the role of sonority and frequency. Since the acquisition of Arabic consonants does not comply with the concept of saliency in determining the order of

consonant acquisition, higher levels of the phonological system such as the prosodic word structures rather than the phonological segments, ought to be further examined.

6.2. The development of Kuwaiti, Jordanian, and Egyptian Arabic phonology

Over a billion people around the world speak many different dialects of the Arabic language. The difference between the Arabic dialects extends over segmental and prosodic aspects of the phonology (Brustad, 2000). The following subsections illustrate the differences in the frequency of the consonant occurrence and their effects on the development of child phonology in three Arabic dialects.

6.2.1. Frequency of consonant occurrence in three Arabic dialects

The frequency of consonant occurrence in Arabic adult-speech has been insufficiently explored by earlier studies. The frequency of consonants in Arabic is limited to child speech samples reported by two small-scale studies of Jordanian Arabic (Amayreh & Dyson, 2000) and Egyptian Arabic (Saleh et al., 2007), with only 13 and 30 speech samples respectively. The reported frequency of consonant occurrence from these studies is summarised in table 6.5, alongside the findings from the current study which has a much larger sample.

	Amayreh & Dyson (2000)	Saleh et al.(2007)	The current study	
Arabic Dialect	Jordanian	Egyptian	Kuwaiti	
Age	1;2-2;0	1;0-2;6	1;4-3;7	
Frequency	Token	Token	Token	Type
Stops	50%	46%	29%	31%
Nasals	12%	19%	16%	14%
Fricatives	17%	17%	31%	25%
Approximants	13%	9%	6%	9%
Laterals	8%	9%	6%	9%
Tap/Trill	-	-	5%	7%
Affricates	2%	-	2%	2%
Emphatics	-	-	4%	4%

Table 6.5: The frequency of consonants occurrence of three dialects of Arabic.

As shown in table 6.5 above, the three most commonly targeted consonant groups are comparable across all three dialects: stops, fricatives and nasals. Minor differences include more fricatives targeted by children acquiring KA than children acquiring other dialects of Arabic, and stops being targeted more frequently in JA and EA than in KA. None of the earlier studies reported the frequency of taps, trills and emphatic consonants; however, one would not expect a higher frequency of occurrence than what has been observed in the KA speech samples.

Consonant Frequency	Amayreh & Dyson (2000)		Saleh et al (2007)	The current study	
	Token	Type	Token	Token	Type
b	8%	10%	10%	8%	7%
t	13%	7%	11%	3%	6%
d	9%	7%	6%	4%	3%
k	2%	4%	-	4%	4%
ʔ	16%	8%	20%	7%	7%
m	7%	8%	8%	7%	6%
n	5%	5%	11%	8%	8%
s	-	-	6%	3%	4%
ħ	2%	3%	4%	3%	3%
ʕ	-	-	2%	3%	4%
h	6%	8%	6%	8%	3%
j	8%	7%	5%	5%	5%
w	4%	3%	3%	3%	4%
l	7%	6%	9%	6%	9%

Table 6.6: Type and token frequency of occurrence of Arabic consonants

All studies listed in table 6.6 have used spontaneous speech samples of Arabic speaking children aged between 1;2 and 3;7. Amayreh and Dyson's (2000) and Saleh et al.'s (2007) studies listed the most commonly produced consonants; and the data from the current study was selected accordingly to allow for a better comparison (the full list of KA consonant frequency of occurrence can be found in section 5.2 of Chapter 5).

The overall frequency of consonants is generally lower in KA compared to other Arabic dialects; this may be due to the fact that the number of consonants in each of the Arabic dialects differs. The number of consonants explored in the current study exceeds those of earlier Arabic studies. The wide range of KA consonants result in overall lower values of frequency of occurrence. The type frequency of JA and KA consonants is comparable; however, token frequency shows few notable differences. For instance, the token frequency of /t/ and /ʔ/ is considerably higher in JA and EA than in KA, whereas /ʕ/ was targeted more frequently in KA than in EA (4% and 2% respectively).

This illustrates the diversity of Arabic dialects, which differ both phonologically and linguistically. Each Arabic dialect has its own vocabulary that may not be

intelligible to speakers of other Arabic dialects. For example, the word 'blanket',
/ɣiˈtˤaːʔ/ or /laˈħaːf/ in MSA, has different realisations and/or lexical forms in
the following dialects:

- Kuwaiti Arabic   /ˈkam.bal/ or /lħaːf/
- Bahraini Arabic   /burˈnuːsˤ/
- Egyptian Arabic   /baˈtˤːaːˑni.jːa/

The linguistic differences between Arabic dialects are also reflected in the
phonology of the spoken dialects in many ways, such as the frequency of
consonant occurrence as well as the rate and order of consonant acquisition.

6.2.2. Frequency effects on the acquisition of consonants in Arabic dialects

The evidence of the frequency effects on the order of the acquisition of
consonants is variable among the three Arabic dialects. As seen in tables 6.5
and 6.6 above, EA- and JA-speaking children target /ʔ/ and /t/ more frequently
than KA-speaking children. Moreover, both consonants are acquired early
(before the age of 2;0) in all dialects of Arabic. If the acquisition age is
influenced by token frequency of occurrence, then we would expect children
acquiring JA and EA to acquire /ʔ/ and /t/ before children learning KA. However,
it can be seen that both /ʔ/ and /t/ were acquired around the same age.
However, as table 6.5 shows, type frequency of /t/ occurrence is matched
between JA and KA (7% and 6 % respectively), which explains the similarity in
the age of acquisition.

On the other hand, the effect of occurrence frequency on production mastery is
less clear in the early stages of development across Arabic dialects. For
instance, data listed in table 6.6 show that, before the age of 2;6, the frequency
of target stops and fricatives is comparable in KA (29% and 31% respectively).
However, children acquiring JA and EA acquired more fricatives at a younger
age compared to children acquiring KA. Likewise, stops are targeted more
frequently in JA and EA than in KA, but they were acquired earlier in KA

speaking children. KA children acquired all stops (except /g/) by the age of 2;7;
whereas JA and EA stops were acquired after the age of 3;0 (Amayreh &
Dyson, 1988; Ammar & Morsi, 2006).

	Amayreh & Dyson (2000)	Saleh et al (2007)	The current study	
Dialect	JA	EA	KA	
Selected age range	1;0-2;0	1;0-2;6	1;4-2;7	
Acquisition criteria	75%	50%*	75%	90%
Stops Nasals Tap/Trill Fricative Approximants Lateral Approx.	/b, t, d, ʔ/ /m, n/ /ʃ, ħ, ʕ, h/ /j, w/ /l/	/b, t, d/ /m, n/ /ɣ, ħ, ʕ/ /j/	/b, t, d, k, ʔ/ /m, n/ /s, h/ /j, w/ /l/ Missing: /d, ɣ, ħ, ʕ/	/ʔ/ /n/ /w/ All except glottal stop

* The consonant has to be produced by more than 5 out of 10 children in each group.

Table 6.7: The acquisition of early Arabic consonants before 2;6

Table 6.7 also highlights the pharyngeal fricative /ħ/ as being acquired earlier in
children learning Egyptian and Jordanian Arabic compared to KA speakers. The
difference of token frequency of /ħ/ in EA and KA is minimal (3.8% and 2.7%
respectively); however, /ħ/ is acquired earlier by EA-speaking children
compared to children acquiring KA. This can possibly be explained by the
higher morphological value in EA (hence functional load). In EA, word initial /ħ/
is used as a bound morpheme to mark the verb future tense, as in the following
examples:

(1)   EA: a. /ħa.ˈru:ħ/   'I-will-go' + 1st person possessive + future tense
              b. /ˈħa:.kul/   'I-will-eat' + 1st person possessive + future tense

The equivalent of the future tense bound morpheme in KA is the word initial /b/,
as in the following examples:

(2)   KA: a. /ba.ˈru:ħ/   'I-will-go' + 1st person possessive + future tense
              b. /ˈba:.kil/   'I-will-eat' + 1st person possessive + future tense

The above examples illustrate the use of future tense bound morphemes in KA and EA. Given that the frequency of occurrence is matched in both dialects, the greater morphological value of /ħ/ explains its early acquisition by EA-children compared to KA-children. Similarly, the frequency of /t/ occurrence is higher in JA and EA than in KA (13%, 11% and 3% respectively) may also result from morphological differences. However, this difference in frequency of occurrence is not reflected in the age of acquisition of the three Arabic dialects. Moreover, the glottal stop occurs more frequently in JA and EA than in KA (10%, 20% and 7% respectively), and is acquired earlier in these two dialects (i.e. EA and JA). Similarly, in KA, the frequency of occurrence of /k/ (4% for both type and token) is higher than its frequency in JA (2%). The /k/ is acquired earlier in KA (before the age of 2;6), but it is not acquired by JA children until the age of 3;0.

The later stages of consonant acquisition in all three dialects show a rather similar phonological repertoire. The data presented in table 6.8 show a later stage of Arabic consonant acquisition beyond the age of 2;7. The age groups were selected from earlier studies to match the ages of children in the current study.

	Amayreh & Dyson (1998)	Ammar & Morsi (2006)	Ayyad (2011)	The current study	
Dialect	JA	EA	KA	KA	
Selected age range	2;7-4;0	3;0-4;0	3;10-4;2	2;8-3;7	
Acquisition criteria	75%	75%	90%	75%	90%
Stops	/b, t, d, k, q, ʔ/	/b, t, d, k, g, ʔ/	/b, t, d, k, g, q, ʔ/	/p, b, t, d, k, g, ʔ/	/p, b, t, d, k, g, ʔ/
Nasals	/m, n/	/m, n/	/m, n/	/m, n/	/m, n/
Tap/Trill		/r/	/r/	/r/	
Fricative	/f, h/	/f, θ, s, ʃ, x, ħ, ʕ, h/	/x, ħ, h/	/f, ʃ, s, z, x, ħ, ʕ/	/f, s/
Approximants	/j, w/	/j, w/	/j, w/	/j, w/	/w/
Lateral Approximants	/l/	/l/	/l/	/l, ɫ/	/l, ɫ/
Affricates		/dʒ/	/ʧ/	/ʧ, dʒ/	
Emphatics		/tˤ, sˤ/	/ðˤ, sˤ/	/tˤ, sˤ/	

Table 6.8: The acquisition of early Arabic consonants between 2;7 and 4;0

It is important to note here that most of the earlier Arabic studies used a 75% criterion to identify the acquisition of consonants. Comparing the development

of KA using the 75% criterion reveals a great deal of similarities in the rate of acquisition. For instance, all stops, nasals and most fricatives are acquired before the age of 4;0 in all Arabic dialects. Additionally, all Arabic stops (including /g/), nasals, glides, and affricates are produced with more than 75% accuracy by the age of 3;7 (c.f. JA and EA). However, only Ayyad's (2011) study has used a 90% criterion for the identification of consonant acquisition; this criterion has been used in the current study. The findings of the two studies of KA phonological development are somewhat comparable except for one main difference. For the acquisition of fricatives, Ayyad (2011) found that /x/, /ħ/, and /h/ were mastered by the age of 4;0; whereas in the current study we found that only /f/ and /s/ were mastered by the age of 3;7. This variability could possibly be explained by the methodological differences between the two studies. The difference between the two KA studies is that Ayyad has used a picture-naming test to elicit all KA consonants in all permissible positions; while the current study the speech samples were recorded spontaneously in free play sessions as a means of capturing the child's sound patterns in a naturalistic context.

The above sections explored the frequency effects on the development of Arabic consonants. In general, the differences among Arabic dialects are not remarkable, and could possibly be justified by the methodological variation between the studies. In order to conduct cross-linguistic comparisons, the order of consonant acquisition will be explored with a special focus on the effect of the ambient language.

6.3. The development of Arabic and English consonants

In reviewing the literature, studies on the acquisition of phonology have always shown that Arabic-speaking children acquire fricatives earlier than English-speaking children (Amayreh & Dyson, 1998). However, the current study does not support this statement. The results of this study show that English-speaking children acquire some fricatives before Arabic-speaking children. The data presented in table 6.9 show that English-speaking children are able to produce

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/f/ and /h/ with 90% accuracy between the ages of 2;0 and 3;0; whereas KA-speaking children do not produce those fricatives with 90% accuracy until after the age of 3;0. The reason for this variability in the findings is due to the criterion used for the identification of consonant acquisition. Almost all earlier studies of the acquisition of Arabic phonology have used 50+% or 75+% criteria for the identification of consonant acquisition (e.g. Amayreh & Dyson, 1998, 2000; Ammar & Morsi, 2006); while the majority of the English normative studies used a 90+% criterion for acquisition (with the exception of Dyson,1988).

Language	English[a]	Arabic[b]	The Current Study	
	5.1.1.2.		75%	90%
Early sounds (<2;0-3;0)	Stops /p, b, t, d, k, g/ Nasals /m, n/ Fricative /f *, h/ Glide /j/	Stops /b, t , d, q*, ʔ/ Nasals /m, n/ Fricatives /f*, ʃ*, ħ, ʕ*, h*/ Glides /j, l, w/	Stops /b, k, d, t, ʔ/ Nasals /m, n/ Trill /r/ Fricatives /f, h/ Glides /j, l, w/	Stops /k, ʔ/ Nasals /m/
Intermediate sounds (3;1-4;0):	 Fricatives /f, s, z, ʃ/ Affricate /ʧ/ Glides /l, w/	Stops / q, k/ Trill /r/ Fricatives /f, θ, s, z, ʃ , x, ɣ, ʕ, h/ Affricates /ʤ*/ Emphatics / ðˤ*, tˤ, dˤ/	Stops /g/ Tap /r/ Fricatives /f, s, z, ʃ, ħ, ʕ, h/ Affricates /ʧ, ʤ/ Emphatics /tˤ, sˤ, ðˤ/	Stops /p, b, t, d, g/ Nasals /n/ Fricatives /f, s, h/ Glides /l, w/
Late sounds (>4;0):	Trill /r/ Fricatives /θ, ð/ Affricate /ʤ/	Fricatives /ð/ Affricate /ʤ, ʧ */ Emphatics /ðˤ/		
* Reported by one study only [a] Dodd et al. (2003), Dyson (1988), McIntosh & Dodd (2008), Smit et al. (1990), and Stoel-Gammon (1987). [b] Amayreh & Dyson (1998), Amayreh & Dyson (2000), Ammar & Morsi (2006), Saleh, et al (2007), and Ayyad (2011).				

Table 6.9: The age of consonant acquisition in Arabic and English languages

Based on the 90% acquisition criterion used in the current study, the following examples are listed to demonstrate how different methodology used by different researchers yield different findings and the outcomes of cross-linguistic studies:

- The acquisition of /l/ has been reported to be acquired earlier by Arabic-speaking children compared with English-speaking children (Amayreh & Dyson, 1998; Ammar & Morsi, 2006). Based on the 90% criterion, the results of the current study shows that children acquiring KA acquire the /l/ at the same age as English-speaking children.
- The apparent early acquisition of fricatives in Arabic has proven to be (somewhat) untrue. Our 90% criteria showed similar findings of those of English studies, where only /f/ and /h/ were acquired before the age of 3;0.
- Earlier studies reported that Arabic-speaking children acquire /k/ before the age of 3;1 (Amayreh & Dyson, 1998); whereas English-speaking children master /k/ before their second birthday (Dodd et al., 2003). The current study shows that KA-speaking children produce /k/ with 90% accuracy as early as 2;0-2;3, similar to English-speaking children.
- The acquisition of /g/ was never reported in earlier Arabic normative studies; the current study found that it is acquired earlier by English- than Arabic-speaking children.
- Dental fricatives are likely to develop after the age of 4;0 by children acquiring both Arabic and English.
- Rhotics were acquired earlier by Arabic-speaking children (with taps and trills as their targets) than by English-speaking children (with the approximant as their target).
- None of the affricates (nor Arabic emphatics) were mastered before the age of 3;7 in either language.

Other methodological differences may influence the comparison with earlier studies (e.g. spontaneous or picture-naming task) and the study design, in addition to normal variability in the early stages of child development. The influence of the ambient language surfaces more clearly as children's phonological systems develop in the second year of life when the variability across children acquiring the same language is radically reduced (Vihman, 1993; 2014). This highlights cross-linguistic variability in groups of children acquiring different languages, which leads to the conclusion that some sounds are acquired earlier in some languages, as compared to equivalent sounds in

other languages. For example, Ayyad's (2011) study is the first normative study to explore the acquisition of KA between the ages of 4;0 and 5;0 and is the only Arabic study to report the age of /ʧ/ acquisition. According to Ayyad (2011), KA-speaking children acquire /ʧ/ after the age of 4;0, which is considered a late stage of acquisition in normative studies of English phonological development (Grunwell, 1981). However, the current study found that KA-speaking children were able to produce /ʧ/ with 82% accuracy between 3;3-3;7. Dyson (1988) found that English-speaking children acquire of /ʧ/ before the age of 2;11. Dyson (1988) used different identification criteria than those of other normative studies of English. For a sound to be counted as acquired it had to occur in at least two lexical items produced by at least 5 of the 10 children in a group; this is equivalent to 50% according to the calculations used in the current study. The current study found that KA-speaking children were able to produce /ʧ/ with 50% accuracy between 2;4-2;7, which is earlier than what was reported by Dyson's (1988) study.

In KA, /l/ was mastered around the same age as English-speaking children. Edwards and Beckman (2008) found that /l/ is mastered earlier by French-speaking children, as compared to English-speaking children, as shown by Chevrie-Muller and Lebreton (1973) cross-sectional study as well as in the analyses of the longitudinal study reported in Vihman (1993; 2013). Similarly, Stemberger and Stoel-Gammon (1991) claim that English-speaking children acquire /t/ before /k/ because of its unmarked coronal place of articulation. However, KA-speaking children acquire /k/ as early as 2;0-2;3 while /t/ is not mastered until 3;4-3;7. Similar findings were reported for children acquiring Japanese, where children tend to acquire /k/ before /t/ (Beckman et al., 2003).

The difference between Arabic and English developmental patterns is not as vast as it has been thought to be. However, an analysis of the phonological acquisition at the prosodic level may reveal interesting data in this regard. The following sections will present a few examples (e.g. clusters acquisition and coda deletion) to the possible differences and how they are influenced by the phonological saliency concept at the prosodic level.

6.3.1. The development of Arabic and English consonant clusters

The acquisition of consonant clusters in any language is a challenging task. Consonant clusters occur in many of the world's languages with variable frequencies. Locke (1983) found that out of 104 world languages, 39% had word-initial clusters only, 13% had final clusters only, and the remaining 48% had clusters in both word-initial and word-final position.

A large variety of clusters are permissible in Arabic, which makes the development of clusters extraordinarily complex. In the current study, we found that KA-speaking children target a total of 33 different types of consonant clusters in word initial position, 10 different types in word medial, and 30 different types in word final position. In English, Dyson (1988) found that at the age of 3;3 children acquiring English produce a mean of 10.7 different word-initial clusters and 7.7 different word-final clusters.

Similar to English, our data shows that the clusters are targeted more frequently word final position compared to word initial clusters. According to target tokens; 53% of all clusters occur in word final position and 31% occur in word initial position, and 16% occur in word-medial position. In English, one third of monosyllables begin with a consonant cluster, and consonant clusters predominate in word-final position (Locke, 1983).

In both languages, a further complicating factor is the use of bound morphemes that creates even more complex phoneme sequences, as in the English word *sixths* and the prefix t- which marks the verb present tense in the KA word /tru:ħ/ 'you-go'. Thus, the acquisition of clusters is one of the longest-lasting aspects of speech acquisition in normally developing children (McLeod, van Doorn, & Reed, 2001).

Children acquiring KA show a dramatic increase in the number of clusters targeted in all three word positions between the ages of 2;4 and 2;7. The number of target clusters in word-final position showed the maximum incline compared to word-initial clusters. The findings of the current study are consistent with those of Dyson (1988) and Watson and Scukanec (1997) who found word-final inventories of consonant clusters of 2- to 3-year-old contain

more consonant clusters than word-initial inventories. McLeod et al. (2001) found that the increased number of target word-final clusters in the speech of children acquiring English is thought to result from the influence of morpho-phonological development (such as the emergence of the plural and past tense morphemes), which increases the number of occurrences of word-final clusters in English. However, this may not apply to children acquiring KA, where the most frequently used bound morphemes result in word-initial clusters rather than word-final ones (Al-Qenaie, 2011).

The influence of consonant sonority on the development of consonant clusters and word shapes will only be discussed briefly in this section, as it shifts the focus of this discussion to the prosodic level of the acquisition of child phonology. In many of the world's languages, there is a general preference in languages for final clusters to have a sound with a lower sonority item follow a sound with a higher sonority. For example, the English final clusters [-mp] and [-nd] are much more common than [-pm] and [-dn] in coda position (Yavaş & Gogate, 1999). The concept of sonority plays a role in the sequencing of multiple onsets and codas in spoken language. Similar to English, in KA there is evidence of a preference for initial clusters to have a sound with a lower sonority item before a sound with a higher sonority. This pattern is observed in the speech of children acquiring KA (data presented in table 5.47 in Chapter 5). The most frequently targeted onset clusters are [br-], [ʃl-], and [dl-], and the most frequently targeted coda clusters are [-lb], [-rf], and [-nd]; all of which conforms with the prediction of the sonority sequencing principle which has been supported by earlier studies of child phonology (Barlow, 2005; Chin, 1996; Gierut & Michele, 1999; Ohala, 1984).

However, the error pattern analysis does not support the universality of the sonority hierarchy hypothesis. According to the sonority hierarchy hypothesis the least sonorous segment is the preferred one and usually reserved in consonant reduction errors (Yavas & Gogate, 1999). Also Chin (1996) assumed that so-called unmarked segments are preferred. Based on both proposals, stops should be preferred over fricatives and obstruents over sonorants because of their lower sonority, and hence unmarked status. According to

findings of the current study, this could possibly explain the [l] dropping in [b] and [p] realisations of the -lb coda cluster; however, the realisation of the -lb coda cluster as [l] contradicts this assumption (see table 5.47 in Chapter 5). Lleó and Prinz (1996) reported similar findings in children acquiring German, who showed a preference to preserve the first segment of the cluster, which is often the less sonorous one in onset clusters, but the more sonorous one in final clusters. Thus, the universality of the sonority factor is also influenced by language-specific structural factors and morphological or articulatory complexity factors, which need to be investigated in further detail (also see Kirk & Demuth, 2005 for detailed discussion).

The ability to produce consonant clusters in KA is due to either: (1) maturation of the children's motor speech mechanism and ongoing anatomical development of the oromusculature or; (2) follows the role of the phonological sonority in the predicting the sequence of consonant cluster acquisition (Yavaş & Gogate, 1999).

6.3.2. *The development of Arabic and English word structures*

The frequency of word structures has been overlooked by most normative studies of the development of child phonology (Smit et al, 1990; Amayreh & Dyson, 2000; McIntosh & Dodd, 2008). Only few studies have touched on the production accuracy of different word structures in Arabic (Ayyad, 2011); some studies have provided a brief description of the occurrence of word structures (Arabic: Ammar & Morsi, 2006; and English: Stoel-Gammon, 1987; Dyson, 1988).

The current study explores both type and token frequency of word structures targeted by children acquiring KA. Since the current study focuses on the segmental level of the acquisition of KA phonology, the production accuracy of different word structures is deferred for a future study. Data presented in table 6.10 below will be addressed in the discussion regarding the development of error patterns below

	Dyson (1988)	The current study	
Age	2;9-3;3	1;4-3;4	
Language	English	Arabic	
Frequency	Token	Token	Type
1-Syllable	86%	24%	11%
2-Syllables	13%	62%	55%
3-Syllables	<1%	11%	30%
4+-Syllables	-	<1%	4%

Table 6.10: The frequency of occurrence of different word structures in the speech of monolingual children acquiring Arabic or English language.

In KA, type and token frequency show a different rank order for the occurrence of word structures of different lengths. In both calculations, disyllabic words are most frequently targeted; however, type frequency of trisyllabic words, in contrast to token frequency, exceeds that of monosyllable words. The combination of findings listed in table 6.10 provides essential information to support the conceptual premise that Arabic children develop longer word structures well before children acquiring English. Since the findings of the current study is limited to child speech, more research on this area of development needs to be undertaken to explore and document the frequency of consonant occurrence in the adult Arabic speech.

6.4. The development of error patterns

Phonological theories aiming to account for similarities of phonological development across languages argue that language independent, innate or universal prerequisites are responsible for phonological development (e.g. Jakobson, 1968; Chomsky & Halle, 1968). In order to explore the claimed universality of phonological development, the following section will compare the findings of the current study with studies focusing on other languages and dialects. The first part here explores the universal error patterns that occur in Arabic as well as other languages, with a particular focus on English. The second part explores the language specific error patterns that have been reported to occur in different dialects of Arabic. The focus of the final part of this section is on the universality of the development of error patterns.

Table 6.11: The development of error patterns in English (E), Jordanian- (JA) and Kuwaiti (KA) Arabic. Shaded cells indicate the age range in which each error pattern occurred; shading key given at the bottom of the table.

Age range	Language/Dialect	1;4-1;11	2;0-2;11	3;0-3;7
(1) Segmental patterns:				
a. Place:	E		E	E
- Fronting	JA		JA	JA
	KA	hatched		
- Dentalization	E			
	JA			JA
	KA			
- Backing	E			
	JA			
	KA	hatched	hatched	
b. Manner	E		E	E
- Stopping	JA		JA	
	KA	KA	KA	KA
- Spirantization	E			
	JA			
	KA			KA
- Gliding	E		E	E
	JA			
	KA			
- De-affrication	E		E	E
	JA			
	KA		hatched	hatched
- De-emphasis	E			
	JA		JA	JA
	KA	KA	KA	KA
- Stridency deletion	E			
	JA		JA	JA
	KA			KA
- Lateralization	E			
	JA			
	KA	KA	KA	KA
c. Voicing	E		E	
-De-voicing	JA			JA
	KA		hatched	
(2) Prosodic patterns:				
a. Affecting syllables:	E		E	
	JA			
- Coda deletion	KA	KA	hatched	hatched
	E		E	E
- Cluster simplification	JA		hatched	hatched
	KA	KA	hatched	KA
b. Affecting word shapes:	E		E	E
- Unstressed syllable deletion	JA		JA	JA
	KA	hatched	hatched	KA
- Metathesis	E			
	JA			
	KA			KA
- Epenthesis	E			
	JA			
	KA			KA

Key:
English (E)		light grey
Jordanian Arabic (JA)		medium grey
Kuwaiti Arabic (KA)		dark
Error pattern did not meet identification criteria		hatched

Table 6.11: The development of error patterns in English (E), Jordanian- (JA) and Kuwaiti (KA) Arabic

Findings from the current study are listed in table 6.11 and are compared with developmental error patterns that were reported in earlier studies on English and Jordanian Arabic for a perspective on dialect- and language-specific differences. Ingram (1989), Pye et al. (1987) and Bortolini and Leonard (1991) point out that differences among error patterns produced by children reflect the phonology of the ambient language (e.g. occurrence frequency, sound classes, and context). For example, regarding the development of KA, a frequency analysis shows that consonants of low occurrence are prone to erroneous production (e.g. emphatics and affricates). In addition, fricatives also tend to occur in high frequency in KA, and this is reflected in the frequency of stopping error patterns. However, this error pattern may not be prominent in the development of other languages with limited fricative types. Thus, the developmental error pattern that occurs in a language may be considered as 'unusual' in another.

Prior to discussing similarities and difference of error patterns occurring in Arabic and English, it is important to shed light on the methodological differences among the studies (e.g. identification criteria), which make the interpretation and generalization of results difficult. All of the earlier studies (with the exception of Dyson & Amayreh, 2000) have identified an error pattern according to the percentage of children within a group that have produced the error. However, in the current study the percentage is based on the number of consonants that have been produced in error rather than the number of children that have produced the error. Dyson and Amayreh (2000) used an identification criterion to report errors that occur in at least 5% of the possible occurrences in an age group. Similarly, in the current study, errors that occur in at least 10% of all possible occurrences in an age group are identified as *age appropriate errors*; errors that occur in 5% or less are reported as *occasional errors,* errors that occur in less than 5% of possible targets are reported as *rare errors.*

6.4.1. The development of Arabic error patterns

The implications of the rich diversity of Arabic language and its various dialects have not been thoroughly explored in developmental studies; this can possibly explain the occurrence of error patterns in one dialect but no in others. The difference in the development of the consonants across Arabic dialects is also reflected in the development of error patterns. Two main differences between KA and JA can be highlighted in the current study. First, in JA, there are three main syllable shapes: CV, CVC, and CCVC (Dyson & Amayreh, 2000). The CVCC shape if often subject to epenthesis to yield CVCVC (e.g. MSA /bint/ 'girl' is realised as [ˈbi.nit]). This epenthesis pattern does not occur normally in KA adult speech, in which three additional shapes occur in KA: CVCC, CCV and CCVCC. This in turn could explain the higher occurrence of cluster simplification in the speech of children acquiring KA compared to children acquiring JA. In the development of KA, cluster reduction was observed after the age of 2;0 with 36% frequency, whereas children acquiring JA produced this error with a frequency of 17% at the age of 2;0. Moreover, as a result of cluster epenthesis in the adult realisations in JA, the frequency of occurrence of coda clusters is expected to be lower than that occurring in KA speech. Conversely, at age 4;0, the higher frequency of KA clusters is exhibited in the early resolution of cluster reduction patterns in the speech of children acquiring KA. Dyson and Amayreh (2000) found that children acquiring JA still exhibited cluster reduction errors at the age of 4;0 (11%), whereas children acquiring KA (the current study) produced fewer cluster reduction errors at the age of 3;7 (9%).

Second, the KA dialect has less dialectal variability than JA. Several allophonic variations that occur in JA are considered as errors in KA:

e.g.,	MSA		JA	KA
	/ð/	→	[d] [ð]	[ð]
	/ðˤ/	→	[dˤ] [ðˤ]	[ðˤ]
	/θ/	→	[t] [θ]	[θ]
	/ʤ/	→	[ʒ] [ʤ]	[ʤ]
	/q/	→	[q], [k], [ʔ], [g], [ɣ]	[q], [g], [ɣ]

From the above examples, the two dialects vary the most in the realisation of the dental fricatives /θ/, /ð/ and /ðˤ/. This variability would alter the intended meaning in KA. For example, the word /ˈhaː.ðə/ 'this' is used in MSA, KA and JA. In JA, to say the word [ˈhaː.də] maintains the intended meaning of 'this'; whereas in KA, the same word [ˈhaː.də] has a different meaning, that is 'he-left-it' + masculine 2nd person. This variability is reflected in the development of stopping error pattern. Error pattern analysis showed that children acquiring KA produced stopping errors with 17% frequency at 2;0, which was reduced to 5% at 3;7. In contrast, children acquiring JA produced stopping error pattern with 15% at 2;0 and 18% at 4;6. The lack of variation in the realisation of KA fricatives (e.g. /θ/, /ð/ and /ðˤ/) contributes to its functional load. Hua and Dodd (2000) suggested that phonological saliency (functional load) is partly determined the capacity of a component in differentiating lexical information of a syllable. In KA, dental fricatives are more likely to contribute to the meaning of the intended word than in JA. Thus, children acquiring KA are more likely to develop those fricatives at an earlier age to preserve word meaning.

Some error patterns were observed in the speech of children speaking both KA and JA; yet not all patterns show the same developmental patterns. While several prosodic error patterns resolved in the speech of KA- and JA-speaking children around the same age (e.g. weak-syllable deletion and coda deletion);, most segmental error patterns resolved in one dialect but remained persistent in another (e.g. lateralization, fronting, and de-emphasis). For example, de-emphasis is specific to the Arabic language. De-emphasis is the most frequently produced error pattern by children speaking KA and JA; the frequency in which it is 77% and 70% (Dyson & Amayreh, 2000) respectively at the age of 2;0. Its frequency remained as high as 44% in JA at 4;0, but it was reduced to 11% in KA at 3;4-3;7. Similarly, fronting resolved by age 2;0 in KA, but was persistent in JA speaking children until the age of 4;0. Similarly, post-vocalic devoicing occurred more frequently in the speech of children acquiring JA than in children acquiring KA. At 2;0, JA children produced this error pattern with a frequency of 16%; while its frequency in the speech of KA children was 4% at 2;0. Children acquiring JA maintained higher frequency of post-vocalic devoicing pattern

(19%) at 4;0; whilst this pattern diminished in KA speech at 3;4-3;7 (1%). Likewise, the lateralization error pattern showed a clear developmental trend in JA, declining rapidly from 35.1% at 2;0 to 10.3% at 4;0, and resolved at 4;4 (Dyson & Amayreh, 2000); while in the speech of children developing KA this pattern remained relatively stable throughout. Its frequency remained in range between 18-21% from 1;4 up to 3;7. Similarly, weak-syllable deletion and coda deletion error patterns were observed in the speech of children acquiring KA and children acquiring JA and resolved in both dialects by 3;7-4;0.

Differences between the development of error patterns in KA and JA are marginal; and can merely reflect differences in methodology. The data elicitation process is the single main difference; Dyson and Amayreh (2000) elicited samples using a 58-word picture-naming task, compared to the spontaneous speech samples used in the current study. Implications of both data collection methods are discussed in section 2.5 of Chapter 2.

6.4.2. Cross-linguistic development of error patterns

Despite the methodological differences listed above, there are similarities in the development of error patterns among children acquiring a variety of languages. For example, children acquiring Xhosa (Mowrer & Burger, 1991) and children acquiring English (So & Dodd, 1995) were found to produce similar error patterns to the ones that were produced by Arabic speaking children during the early stages of phonological acquisition (Dyson & Amayreh, 2000).

At the segmental level, three error patterns are often produced by children acquiring English and Arabic: stopping, de-affrication, post-vocalic devoicing, and /r/ substitution. Stopping, for example, occurs in the speech of KA and English children (McIntosh & Dodd, 2008) with a relatively similar frequency at 2;0-2;5, which is in the range of 17-21%. However, this error pattern tends to resolve earlier in KA than in English. According to McIntosh and Dodd (2008), the frequency of stopping remains as high as 25% at 2;6-2;10 in the speech of children acquiring English; whereas the frequency reclines in the speech of KA children down to 14% at 2;4-2;7. Watson and Scukanec (1997) found that /v/,

/θ/, and /ð/ are the most frequently affected consonants in the development of stopping error patterns. Similarly, findings of the current study also found that dental fricatives, /θ/ and /ð/, are the most frequently affected fricatives out of the 11 fricative types that normally occur in KA. The number of fricative types that occur in English are far fewer than those which occur in KA, which could possibly explain their early acquisition in KA compared with English. It is possible that fricatives are more salient in the Arabic language compared with English. It should be noted that fricatives and affricates are among the least targeted sounds in English (Johnson & Reimers, 2010; Ingram, 1989; Zamuner, 2003). This explains the persistence of stopping error patterns in addition to their articulatory complexity.

Error patterns affecting the realisation of /r/ provide an example of the typological differences between Arabic and English languages. English children tend to vocalize /r/ while Arabic children are more likely to lateralize /r/ to [l]. Although the error frequency is comparable (at least at age 2;0) (Watson and Scukanec, 1997), different types of errors were observed in the speech of children acquiring Arabic and English. Out of all /r/ realisation errors that were observed in the speech of KA children; 23% were lateralized and 7% were glided to [j] and [w] (4% and 3% respectively). Further, children acquiring English were found to vocalise all /r/s to [w] and [j]. Similar findings of /r/ lateralization patterns were reported in developmental studies of Arabic (Ayyad, 2011; Dyson & Amayreh, 2000), Italian (Bortolini & Leonard, 1991), Portuguese (Yavaş & Lamprecht, 1988), and Xhosa (Mowrer & Burger, 1991). All of these languages comprise of tap and trill /r/s, while the English /ɹ/ is an approximant. The difference in /r/ articulation between English and Arabic offers an explanation for the different realisations (Dyson & Amayreh, 2000; Mowrer & Burger, 1991). The Arabic /r/ shares the alveolar place of articulation with /l/, whereas the approximant /ɹ/ involves retroflexion or bunching of the back of the tongue with lip rounding and no alveolar contact. The lack of alveolar contact is also found in the articulation of /j/, while lip rounding is shared with /w/ production. Dyson and Amayreh (2000) suggested that the production of /r/ poses a difficult articulatory task in the development of Arabic phonology, which results in the variability of realisation simplification across languages.

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Prosodic error patterns were also observed in the speech of children acquiring Arabic and English, such as: weak syllable deletion, coda deletion, and cluster reduction. Weak syllable deletion patterns were observed in the speech of KA and English speaking children. The frequency of weak syllable deletion error pattern in KA speech is lower than in English. In KA, the frequency range was between 5% and 8% between 1;4 and 3;7 while that children acquiring English tend to delete unstressed syllables infrequently at 3;0 (Kehoe, 2001); between 1;10-2;10 those children acquiring English deleted half of the unstressed syllables of trisyllabic target words (Kehoe, 2001). However, children acquiring English rarely produce trisyllabic words (frequency <1%) at 2;9-3;3 (Dyson, 1988). In contrast, children acquiring KA (Arabic in general) tend to produce longer words well before children acquiring English. Findings of the current study shows 11% of KA children's target words (tokens) that are of 3-syllables length between 1;4-3;3. Also, 30% of word types in KA child speech are trisyllabic, and 55% are disyllabic words.

In children's earliest truncation patterns, the most frequently preserved syllable is the stressed syllable closest to the end of the word, regardless of whether it receives primary or secondary stress (Archibald, 1996; Fikkert, 1994). The theoretical accounts of the development of weak syllable deletion fall into three main approaches: the *prosodic structure* (e.g. Fikkert, 1994; Demuth & Fee, 1995; Demuth, 1996; Pater & Paradis, 1996), the *trochaic constraint* (e.g. Gerken, 1991, 1994), and the *perceptual salience* (e.g. Blasdell & Jensen, 1970; Echols & Newport, 1992). All approaches account for two main aspects of the development of syllable deletion patterns (Pater & Paradis, 1996): (a) the size or shape of the resultant production and (b) which syllables of the target structure are preserved (Kehoe, 2001).

Demuth (2001) proposed an additional concept that could possibly account for the frequency of occurrence of word structures in the ambient language and their function within the language (e.g. morpho-phonological structures in Arabic).

For example, Demuth[3] (2001) found that children acquiring Spanish tend to acquire initial weak (unfooted) syllables several months before English-speaking children; whereas children acquiring English acquire coda consonants several months before Spanish-speaking children. Roark and Demuth (2000) showed that the earlier acquired structures in each language are much higher in frequency relative to other words and syllable structures. Consequently, children are more likely to produce higher-frequency syllable shapes and prosodic word shapes before producing structures that occur less frequently. Based on the findings of the current study, the predominance of bi-syllabic and tri-syllabic words in KA children's speech can possibly contribute to the development of weak syllable deletion error patterns. Children acquiring KA truncate weak syllables less frequently than children acquiring English at the same age, as English-speaking children's early words are simple monosyllabic words (e.g. Dyson, 1988; Ingram, 1974). Thus, as multisyllabic word structures occur with high frequency in both Arabic and Spanish languages, early sensitivity to the frequency of word structures could possibly apply to the acquisition of Arabic.

The difference in syllable shapes in Arabic and English influences the development of prosodic error patterns. In both languages, there is marked predominance of simple CV syllable structures during the initial stages of language development. However, children acquiring KA were found to target more complex structures at a younger age compared to children acquiring English. This is expected to result in earlier acquisition of complex structures with demanding articulatory complexity. This can be seen in the following two conditions: first, the assimilation of the Arabic definite article /ʔal-/ 'the' is attested across dialects of Arabic as well as in MSA. The Arabic definite article

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[3] Demuth (2001) suggested that stressed or strong (S) syllables and the unstressed, or weak (w) syllables that follow them form *trochaic feet* - structures are seen as playing an important role in determining which syllables will be retained or omitted in children's early speech around the ages of 2;6-3;6, especially in stress-timed languages like English, Spanish and Dutch.

/ʔal-/ (realised as /ʔil-/ in KA) results in complete assimilation when it precedes a 'lunar' consonant (i.e. {+coronal} {+fricative}) (Al-Qenai, 2011).

The definite article absorbs their features, rendering two identical abutting consonants in a regressive assimilation manner. For example, /ʔal.tˤa.ˈbiːb/ 'physician' is realised as [ʔitˤ.tˤa.ˈbiːb] or [ʔi.tˤːa.ˈbiːb] resulting in the creation of word-medial geminate which alters the word shape (CVC.CV.CVVC → CV.C:V.CVVC). Second, the difference between 'optional' bound morphemes in child language and 'compulsory' ones in adult language (in KA) is often reflected in the word shape. It is important to note here that there are no 'optional' morphemes in spoken adult KA; however, in child speech, the meaning of the intended utterance is often preserved (with some degree of ambiguity) even in the absence of the morphological segments. For example, the word [ruːħ] 'go' may be intelligible to an adult listeners when it is used by a child to convey the intended meaning of the adult form /ʔa.ˈruːħ/ 'go + 1st person singular pronoun', thus the child can possibly communicate the intended meaning without the need to the produce the bound morpheme which adds to the word length and complexity. The tendency of using short, simple words is reflected in token frequency. The token frequency of monosyllable words was much higher than its type frequency in the speech of KA children.

6.5. Summary

The data presented in this study established a comprehensive developmental baseline for children acquiring KA aged between 1;4 and 3;7. The effect of occurrence frequency has been explored within and across languages.

Type and token frequency of target consonants was examined in the speech of KA children, along with word and syllable shapes. It is evident that the overall consonant production accuracy is sensitive to type frequency (consonant groups); however, it is not sufficiently specific to predict the order of acquisition of all KA consonants occurring in different word contexts. In monosyllabic words, when word length and stress effects are eliminated, consonant

production accuracy was predictable based on token frequency but was less accurately predictable for consonants occurring in complex word structures of KA.

At the prosodic level, children acquiring KA showed apparent discrepancy between type and token frequency, which could possibly indicate their personal preference for certain word structures. For example, there were apparent differences in target word shapes between type and token frequency. Children acquiring KA tend to target disyllabic tokens more than monosyllabic ones (19% and 2% respectively); however, the type frequency difference between the two word shapes was not vast (4% for monosyllabic and 6% for disyllabic word types). Therefore, children acquiring KA tend to prefer disyllabic over monosyllabic words. Although this may also be the case in KA child directed speech, the assumption that children display a preference for one word structure over another is undeniable.

According to the input-based account of phonological acquisition, children will initially acquire the most frequent segments (token), based on their position in the word types in the input (e.g., coda or onset segments). Zamuner (2001) examined large data derived from several different corpora of the Child Language Data Exchange System (CHILDES) as well as dictionary data. Despite the fact that Zamuner's analysis was limited to coda production in CVC monosyllable words, similar findings were also observed in the current study, where the production accuracy of onset consonants in monosyllable words were found to be sensitive to token frequency. However, the effect of token frequency on target word shapes was unclear. The difference between the token frequency of monosyllabic and disyllabic words was less than the difference found in type frequency; which signals children's preference for simple monosyllable word structures. Whereas, the influence of frequency on the development of error patterns was evident in error patterns affecting word and syllable shapes. That is, when type and token frequencies were matched, the influence of frequency on the development of segmental error patterns was not evident. On the other hand, the development of prosodic error patterns (affecting word or syllable shapes) was influenced by both type and token

frequency. This means that the acquisition of phonological segments is influenced by frequency, whereas the acquisition of word shapes is not.

Further evidence was found to support Zamuner's study in the speech of KA children. The frequent use of the target CV.C:VV.CV word structure by the children is due to the frequent use of this word shape in children's nicknames (e.g., Haya /ˈha.ja/ → [ha.ˈj:u:.na]; Bader /ˈba.der/ → [ba.ˈd:u:.ri] and so on). In this example, two main factors could attribute to the frequency of occurrence of the word shape: first, if the structure is commonly used in creating children's nicknames, its high frequency in child directed speech is predictable; however, this needs to be further investigated in the absence of CDS corpora for Arabic. Second, the presence of a word-medial geminate, along with the iambic stress, adds to the word's acoustic saliency; this makes it more noticeable in running speech and more likely to be learned by the child (Khattab & J. Al-Tamimi, 2013). The above examples illustrate that experience and auditory feedback could possibly account for frequency, phonological saliency, personal interest and preference, as well as exposure to the language.

Furthermore, as is well known from, for example, the very late mastery of /ð/ in English, frequency cannot be the sole determining factor. Similar findings were also observed in the development of KA phonology. For example, despite the high token frequency of /ð/, this sound was not acquired up to the age of 3;7. As for English, the frequency of /ð/ occurrence was due to the extensive use of function words rather than content words in the language. But what about children who were able to produce a consonant that occurs in low frequency content words?[4] For instance, data from the current study have shown that a child who owned a pet lizard (/ðˤab/ in KA) was able to produce /dˤ/ with high accuracy. In addition to the effect of input, this could possibly reflect personal interest, social or environmental factors, or even perceptual saliency of certain segments or structures of the language.

A cross-linguistic comparison was carried out with a special focus on Arabic and English. In both languages, there was a general tendency for consonants used

[4] Note that the frequency of content words in KA is unknown; however, given the context, having a pet lizard is not a common practice in Kuwait.

most frequently to be less complex with some exceptions (e.g. dental fricatives). The influence of frequency was explored for each language, since the frequency effect is considered a language specific factor. It has been shown that frequency was capable of predicting the order of acquisition of phonological segments (i.e. consonants) of each language but was less effective in predicting the development of larger prosodic units (i.e. word and syllable shapes). At the segmental level, consonants from both languages were acquired in a similar order of acquisition but at different rates. With regard to frequency, consonants that were targeted less frequently were prone to erroneous production (e.g. fricatives and affricates in both languages) more than consonants that were targeted with high frequency. Consequently, segmental errors were sensitive to frequency; however, prosodic error patterns were less predictable.

There is a general tendency for less complex and more frequent sounds to be acquired early in both languages (with some exceptions). This observation (partly) supports Jakobson's prediction of acquisition of phoneme classes because it is fairly close to the general progression of acquisition of phoneme classes as phonetic targets. For example, Arabic and English stops generally precede fricatives and affricates. However, glides precede liquids only in English, but not in Arabic. Also, velars are indeed usually acquired later than labials and dentals in English. However, this was not the case for Arabic and several other languages such as Finnish (Kunnari, 2003; Savinainen-Makkonen, 2007) and Japanese (Beckman et al., 2003). Furthermore, in languages employing complex articulations, such as emphatics in Arabic, simply articulated consonants such as [t] are mastered before more marked phones such as the emphatic [tˤ]. Similar findings were also reported for Quiché where [k] is mastered before the glottalized [k'] (Pye et al., 1987). Jakobson's implicational hierarchy is about individual sounds, not about groups, and it is explicitly about phonetic contrasts, not phonological targets. However, our data have shown extensive variability in the order of individual consonant development, which in turn violates the inferences that are typically drawn from Jakobson's implicational laws.

At the prosodic level, CV syllables were the most frequently used in both languages; yet in Arabic, the CV syllables were produced as part of longer words. The prosodic error patterns (affecting word and syllable shapes) were less frequently observed in the speech of children acquiring KA, which reflects the complexity of Arabic word structures compared with English. Moreover, the frequency effect is reflected in the course of development of segmental errors; however, frequency per se is less predictable for the development of prosodic error patterns. Thus, the differences between the phonological acquisition of Arabic and English are is attributed to the specific nature of the two phonological systems.

The similarities and differences highlighted in this cross-sectional comparison require theoretical interpretations. Existing phonological notions (e.g. concepts of markedness, functional load and feature hierarchies) cannot account for some of the patterns revealed by this study. A satisfactory explanation of the findings requires more attention to the specific characteristics of the linguistic system of the acquired language. It is proposed that the frequency of the phonological unit in the language system determines the order of acquisition, at least at the segmental level.

6.6. Theoretical implications

From the outset of this thesis, I adopted a bottom-up approach to phonological development, beginning with an exploration of the child's own speech in a naturalistic setting to the discovery of developmental trends which may or may not be accounted for by various theoretical frameworks. For instance, the effect of frequency has been accounted for by formal and functional theories of phonological acquisition, either in direct or indirect accounts.

Some of the formal phonological theories do not account for frequency across languages. In a rule-based theory, such as SPE (Chomsky & Halle, 1968) it is at best possible to predict that the more natural rule (i.e. with fewer features) should be encountered more frequently in the world's languages. However, this is a relative frequency prediction rather than a 'rule', and absolute predictions are impossible to apply cross-linguistically.

In theories that are based on rule-and-constraint (e.g. Stampe, 1969) frequency predictions are even more obscured. In these theories, adult target forms function as universal filters (or constraints) to which output patterns have to comply. However, the well-formed adult conditions are typically inviolable and are intended to express universal patterns. These conditions do not account for variability in either adult or child speech.

Theories that are purely constraint-based, such as OT (Prince & Smolensky, 2008b), assume that constraints are innate and therefore universal to all languages. OT accounts for cross-linguistic variations in the relative ranking of constraints. For instance, not all faithfulness constraints are satisfied at all times, leading to differences between input and output forms. Similarly, not all markedness (or structural) constraints are satisfied at all times, and this allows typologically more marked forms to occur in certain circumstances. However, OT does not limit ranking or re-ranking of constraints in various conditions; while this allows for wider variability it also limits its ability to predict the rate or order of acquisition of different phonological units.

Despite the fact that most formal phonological theories do not provide direct accounts for frequency, most do so indirectly. Jacobson's structionalist model posits that unmarked sounds that are less-complex are targeted more frequently and acquired earlier than more complex, less frequent sounds. Despite the controversy around the concept of markedness (see section 1.4.1 of Chapter 1), findings of the current study provide partial support for Jacobson's theory. That is, children acquiring Arabic and English tend to acquire less complex and more frequent consonants. However, by examining the frequency effect on the acquisition of groups of consonants (e.g. stops, fricatives, nasals etc.) we found that frequency alone was not specific enough to predict the acquisition of all consonantal segments; furthermore, it was even less predictable at the word and syllable level (i.e., prosodic level).

At the prosodic level, most of the formal models agree that CV syllables are the most natural or unmarked and are acquired at an early stage of development.

Findings of the current study provide partial support for this concept. The CV syllable is the most frequently targeted syllable shape in Arabic and English; however, in Arabic the CV syllable occurs more often within a multisyllabic word context (e.g., CV.CV.CV) rather than in monosyllable words as it does in English. Also, it is important to note that in many cases, one CV-syllable of the CV.CV.CV word often holds a morphological value. The closest theoretical explanation can be based on a generative approach, which provides an explicit account for the underlying representations. Chomsky and Halle (1968) described the role of underlying representations in adult phonology as morphopnonemic rules that derives surface strings of phonemes. It assumes that children have adult-like underlying representations. However, since the early stages of developing lexical representations are difficult to measure (in production), this assumption was inadequately supported by developmental studies.

On the other hand, functional models tend to provide better accounts for frequency on the course of phonological development as well as variability among children. A functionalist model sees phonology as being rooted in speech-motor and perceptual systems rather than in universal grammar. While it acknowledges a certain role for biological constraints, it also argues for a greater environmental influence on consonant development (Menn, 1983). The environmental influence is commonly described as the effect of functional load of consonants in the language (Pye et al., 1987) or the effect of input-frequency in the ambient language (Menn & Stoel-Gammon, 2000).

According to the functionalist approach, frequency in the ambient language plays a major role in the development of child phonology. Pierrehumbert (2003) posits that the adult language is too variable to provide a *universal* set of distinctive features. Instead, the child's learning is 'bottom-up' (from perception to categorization of input) as well as 'top-down' (from frequent input of familiar words and patterns). This in turn allows for a combination of *implicit* categorization and *explicit* word learning, with cycles of distributional learning that lead to generalization over word forms to create a phonological grammar. According to this model, the two main sources of child knowledge are:

probabilistic phonological knowledge (Vitevitch & Luce, 1999) and *exemplar learning* process (Jusczyk, 1997). The exemplar learning theory suggests that words are first learned as individual instances, which retain the abstract details that come with them (e.g., voice, context, interest, personal preference, etc.). Multiple experiences of the same word result in categorization of the retained abstraction, which leads to the production of the learned word. The probabilistic phonological knowledge is based on distributional learning of the ambient language in the form of input frequency. The frequency effect derives from distributional learning of ambient language patterns; that is, high frequency tokens are more likely to be retained in memory (*implicit*) and then recalled (*explicit*). Both sources of phonological knowledge contribute to a life-long non-linear learning process that begins in early infancy and continues into adulthood.

Vihman and her colleagues elaborate on Pierrehumbert's approach in the development of whole-word phonology. They suggest that the learning process is initiated far earlier than what is suggested by the original hypothesis (Keren-Portnoy, Vihman, DePaolis, Whitaker, & Williams, 2010; Vihman, Keren-Portnoy, DePaolis, & Khattab, 2009). They also argue that production experience plays a critical role in the process of shifting from exclusive signal-based to both signal- and lexical-type-based knowledge. The whole-word approach places a great deal of emphasis on individual differences and nonlinear advances in the development of child phonology (Vihman, 2014). For instance, when the child learns a new word, the first lexical production recalls the specific adult lexicon that the child has been exposed to, "leading to new cycle of statistical learning based on types, not tokens" (Vihman, 2014, p.289). According to the whole-word phonology model, the child's own production will have a great impact on the learning process of new phonological structures. This explains the insignificant difference between type and token frequency that has been found in the current study. Since both frequencies were derived from the child's own production, similarities (and differences) between type and token frequency found in the current study are attributed to the child's individual preference and selectivity (see section 5.2 of Chapter 5). It is important to note that the child's selectivity of certain word structures may or may not reflect the

child's lexical representation of the selected word. However, even with the observed proximity of type and token frequency, we have found a great deal of individual variability that has been obscured within the cross-sectional study design and age-group stratification that has been used. Because variability is unavoidable in spontaneous speech sampling method, most individual variability has been neutralized by the application of identification criteria of the current study (see Section 4.7.3 of Chapter 4).

The functional approach to phonological acquisition holds the most valid account for the variability observed in the development of child phonology. Menn and Vihman (2011) presented substantial data showing the variability across many children acquiring different languages as well as variation within each of a small number of children acquiring English in the early stages of phonological acquisition. They found that, with time, children gradually become more systematic and show a great deal of within-language similarities which supports their claim that phonology emerges on the basis of experience with language production and self-perception. Vihman et al. (2009) and Keren-Portonoy et al. (2010) argue that production experience plays a critical role in the process of shifting from exclusively signal-based to both signal- and lexical-type-based knowledge in the early stages of phonological development. In support of this claim, children acquiring KA were found to target a wider range of word types around the age of 2;6; which is the age when the number of targeted words showed a dramatic increase. At the age of 2;6, there was a marked decrease in the frequency of error patterns that affects syllable shapes (e.g., coda deletion and cluster reduction). This could also reflect an exemplar learning approach, which suggests the early implicit learning and knowledge at the sublexical level (Pierrehumbert, 2003), and the explicit learning or knowledge at the lexical level (Vitevich & Luce, 1999). However, the distinction between the lexical and sublexial levels was not evident in the KA data, as the segmental error patterns were exhibited across all age groups in a progressive developmental pattern. If there were a clear-cut shift, we would expect for the segmental error patterns to resolve before the onset of the lexical growth spurt and the prosodic error patterns to subsequently appear. However, this was not

the case in the development of KA, since the two types of knowledge are expected to develop side by side rather than a sequential pattern.

A comprehensive phonological theory should be able to predict the sequence and rate of child speech sound development and accounts for inter- and intra-child variability. As such, a middle-ground theory is needed to acknowledge aspects from both formal and functional theoretical accounts. For instance, the universality of formal models is rather considered as commonality in functional views, not to overlook the underlying organic factors that guide the development of child phonological system. Similarly, the marked segments (or constraints) are better addressed as tendencies rather than 'rules', which will allow valid accounts for the observed variability within and between children.

The challenge for a theory of phonological acquisition is to provide a systematic account of variation that is observed within and across children's speech over the course of development. Despite a continued search for universal patterns and tendencies, it is well recognized that different children acquire different sounds at different rates and in different orders. Moreover, the very same words may even be produced in many different ways, where an acquired sound may be used correctly in some target words or word positions, but not in others. While some cases of phonological variability can be directly traced to the effects of phonetic context, input frequency or phonological saliency, the majority of other cases seem to be less systematic or predictable. Consequently, the observed unpredictable variability in phonological acquisition has attracted functional explanations; this is often attributed to children's unique cognitive styles, learning strategies and preference for (or avoidances of) certain sounds, word shapes, or articulatory routines. These factors have all been thought to influence the acquisition process, thereby resulting in the individual differences that are observed.

6.7.　Clinical implications

This thesis has general clinical implications related to assessment and treatment of children with phonological delays or disorders, and provides more specific insights on working with young children acquiring Arabic.

The development of speech-language therapy services in Kuwait is still in its infancy. The lack of standardised speech and language tests has led clinicians working in Kuwait to use their own clinical judgement and experience to assess the children's speech and language abilities and provide intervention accordingly. Rafaat, Rvachew, and Russell (1995) found that clinicians' judgements of the severity of phonological impairment in children younger than 3;6 of age has been found to be somewhat unreliable. The authors argued that clinicians are unfamiliar with the normal phonological data of children as young as 3;6. They also argued that clinicians need appropriate guidelines for choosing remediation targets and evaluating progress if therapy is recommended for children younger than 3;0 (Watson & Scukanec,1997). The data presented in the current study provide valuable information that can be used by clinicians working with Arabic-speaking children. For instance, the frequency charts can guide the selection of target consonants to be used in therapy. The acquisition table (table 5.13) can also be used as a diagnostic guide to identify children with phonological delay. However, this data should be used cautiously as it is still not standardised on a large number of children, but this is planned for the near future.

Clinicians and researchers working with children acquiring other Arabic dialects can employ the comprehensive data derived from this thesis. As the phonological repertoire of children acquiring KA was found to be inclusive of all consonants that occur in other dialects of Arabic (e.g., Jordanian and Egyptian), and because this research included all consonants of other dialects of Arabic, the normative data developed in the current study can be used for early identification of children with phonological delay or disorder before the age of 4;0.

The current study initiates the process of establishing a reliable and valid phonological assessment test that aids the clinician decision in identifying Arabic children with phonological delay. The purpose of the current study was to profile the phonological system of KA-speaking children. This profile is based on children's productions during naturally occurring conversations without an attempt to elicit specific words. Thus, a future test can be built on the words that

are known to children acquiring KA by extracting word lists of the most frequently targeted words that were produced spontaneously by children who took part in the current study. This will ensure the child's knowledge of the target words, which can be elicited by a picture-naming task.

An additional option is the development of screening tools to be used for early specialist referrals of children with possible speech disorders. The word lists could possibly be employed to develop a short questionnaire to be used by nursery carers and pre-school teachers for early identification and referral to speech therapy centres in cases where early intervention is required.

6.8.   Limitations and directions for future research

As this is the first study to investigate the early stages of Arabic phonological acquisition, some findings warrant replication with larger samples of children acquiring Kuwaiti as well as other dialects of Arabic.

It is important to note here that the relational analysis carried out in the current study has partial control over the effects of prosodic position on children's production. For example, the analysis of consonants in all word positions revealed that the frequency of occurrence did not make a clear distinction between different word classes. This should have been considered since in many languages, function words and content words have different phonological patterns and frequencies (Zamuner, 2001, 2004).

The current study did not perform a specialized statistical analysis to either support or reject the reported findings. The lack of sufficient data on Arabic language in general made it almost impossible to carry out valid statistical analysis without the use of rather complex analytical tools such as R-analytics. Using R-analytics requires thorough knowledge of computer programming, such as writing scripts, and often involves extensive collaborative work with experts in the field of computational linguistics.

In order to build a representative CDS corpus for Arabic speakers, the recordings could have been transcribed to include the parent's speech. This would also provide invaluable information regarding the occurrence frequency derived from adult speakers of KA. There are plans in place to make the data from for the current study available to the public through the Child Language Data Exchange System (CHILDES) (MacWhinney, 1992, 2000) and the TalkBank (MacWhinney, 2007) projects. The available databases include a rich variety of computerized transcripts from language learners. Most of these transcripts record spontaneous conversational interactions. The speakers involved are often young monolingual, typically developing children conversing with their parents or siblings. The database also includes transcripts from bilingual children, older school-aged children, adult second-language learners, children with various types of language disabilities and people with aphasia. The transcripts include data on the learning of 26 different languages. However, the Arabic corpus on the CHILDES database is limited to only four recordings of children acquiring Tunisian Arabic.

Future research could possibly use the data from the current study to explore the development of the acquisition of KA phonology at the prosodic level this would complement the findings of this research given its focus on the segmental level of acquisition. Examining the prosodic development on KA can enrich our understanding of the nature of morpho-phonological structures of Arabic in general. As Arabic grammar is often integrated into the lexical unit to mark gender and tense, the study of word shape development requires a detailed analysis of the syntax of spoken Arabic (Brustad, 2000); this has been rarely described in the current literature.

The data presented in this thesis may be used either for cross-linguistic comparisons or for assessing children with atypical phonology. It is important to note that many aspects of influencing factors have been obscured by the cross-sectional study design. This masks the individual variability within a child's speech and across groups of children. Ideally, longitudinal studies with extensive and comprehensive analysis of speech samples that accounts for

social and environmental factors for each child would offer an insight into what really shapes our language development. However, this information needs to be explored at an individual level rather than with groups of children in order to measure the effects of social and interpersonal factors. Given the data of the current study will be made publically available in the near future, there is a potential for a blooming era of knowledge to arise in the field of Arabic development to be explored by many researchers around the world.

Appendix A: List of target words and word structures used spontaneously by KA-speaking children

Table A.1 lists the word shapes tokens that were targeted by KA-speaking children during the 30-minute spontaneous speech recording sessions. The table excludes word shapes with low frequency of less than one per cent.

Table A.2 lists the word types that were frequently targeted in KA children's spontaneous speech samples. The broad phonetic transcriptions of all words are listed alongside; word structures, target stress patterns, number of occurrences, frequency percentage, and the English translations. The table excludes word shapes with low frequency of less than one percent.

Table A.1: Token word shapes targeted by KA-speaking children

1;4-1;7	no.	Freq.	1;8-1;11	no.	Freq.	2;0-2;3	no.	Freq.	2;4-2;7	no.	Freq.	2;8-2;11	no.	Freq.	3;0-3;3	no.	Freq.	3;4-3;7	no.	Freq.
CV.CV	273	24%	CV.CV	427	41%	CV.CV	577	33%	CV.CV	616	15%	CV.CV	580	15%	CV.CV	680	19%	CV.CV	692	17%
CVVC	196	17%	CVVC	114	11%	CVV	186	11%	CVVC	280	7%	CVVC	306	8%	CVVC	295	8%	CVV	324	8%
CV.CV	102	9%	CVC	70	7%	CVVC	177	10%	CVC.CV	204	5%	CVC.CV	214	5%	CVV	238	7%	CVVC	286	7%
CVV	79	7%	CVV	63	6%	CV.CV	91	5%	CVV	199	5%	CVV	210	5%	CV.CVC	184	5%	CVC	261	6%
CV.CVVC	67	6%	CVC.CVCC	62	6%	CVC.CVC	83	5%	CVC	188	4%	CVC.CVC	199	5%	CVC.CVC	182	5%	CV.CV	224	5%
CV.CVV.CV	65	6%	CV.CV	48	5%	CV.CVV	75	4%	CV.CVVC	158	4%	CVC	182	5%	CVC.CVC	176	5%	CVC.CVC	195	5%
CV.C:VVC	45	4%	CV.C.CV	37	4%	CVC	70	4%	CV.CVV	146	3%	CV.CVVC	168	4%	CV.CVV	141	4%	CV.CVVC	169	4%
CV.C:V	40	4%	CV.C:V	32	3%	CV.CVVC	66	4%	CVC.CVC	144	3%	CVC	150	4%	CVC	137	4%	CVC.CVVC	162	4%
CV.C:VV	39	3%	CV.CVV.CV	28	3%	CVC.CV	63	4%	CV.CVVC	142	3%	CV.CVC	146	4%	CV.CVVC	130	4%	CV.CVC	150	4%
CVC	37	3%	CV.CVVC	21	2%	CCVV	56	3%	CV.CVC	135	3%	CV.CV	136	3%	CV.CV	129	4%	CVC.CVC	132	3%
CV.CVC	35	3%	CV.CVV	17	2%	CV.C:V	37	2%	CV.CVC	133	3%	CV.CVVC	133	3%	CV.C:V	119	3%	CVC.CVC	132	3%
CCVV	27	2%	CV.C:VV.CV	15	1%	CV.C:VC	33	2%	CV.C:VV	107	3%	CV.CV	130	3%	CV.C:VV.CV	82	2%	CV.CV	106	3%
CV.CVV.CV	20	2%	CVC.CVC	14	1%	CVC.CVC	31	2%	CV.CVV.CV	105	3%	CV.CVV	120	3%	CV.CV	77	2%	CCVVC	80	2%
CV.CVVC	20	2%	CV.CVC	12	1%	CVC.CVV	24	1%	CV.C:VV.CV	105	3%	CV.C:VV	117	3%	CVC.CVVC	64	2%	CV.CVV.CV	79	2%
CVC.CVC	14	1%	CV.C:VVC	11	1%	CV.CV	20	1%	CV.C:V	104	2%	CVC.CVC	98	2%	CCVVC	62	2%	CVCC	76	2%
CVV.CV	10	1%	CVV.CVV	8	1%	CV.CVC	19	1%	CCVVC	99	2%	CVC.CV.CV	75	2%	CVC.CVV	62	2%	CV.C:VV	75	2%
CVCC	10	1%	CCVVC	7	1%	CVVC.CVV	14	1%	CV.C:VVC	95	2%	CCVVC	67	2%	CV.C:VVC	55	2%	CV.C:VV.CV	70	2%
CVV.CVC	8	1%	CVCC	6	1%	CV.CV.CV	11	1%	CVCC	93	2%	CV.C:VV.CV	66	2%	CVC.CV	51	1%	CV.CVV	67	2%
CVVC.CV	7	1%				CV.CVV.CV	11	1%	CV.CV	88	2%	CVCC	55	1%	CV.CVV.CV	49	1%	CVC.CVVC	60	1%
CCVVC	6	1%				CVV.CVC	11	1%	CVC.CV.CVVC	83	2%	CV.CVV	53	1%	CV.C:VV	43	1%	CCVV.CV	51	1%
CVC.CVV	6	1%							CV.CV.CV	70	2%	CV.C:VVC	50	1%	CV.CV.CV	36	1%	CVC.CVV	42	1%
									CV.C:VC	62	1%	CCVV.CV	47	1%	CVCC	35	1%	CVC.CVV	37	1%
									CV.CVCC	60	1%	CV.CVV	47	1%	CV.CVV	34	1%	CVC.CV.CV	32	1%
									CCV.CV	54	1%	CV.C:VV.CVV	43	1%	CV.CV.CV	29	1%	CVC.CV.CVVC	31	1%
									CVC.CVV.CV	50	1%	CVC.CV	42	1%	CCVV.CV	28	1%	CV.C:VV.CVV	26	1%
									CV.C:CV	47	1%	CV.C:V.CV	37	1%	CV.CCV	25	1%	CV.CCV	26	1%
									CV.CCV	38	1%	CVC.CVC	36	1%	CV.CVC.CV	19	1%	CV	24	1%
									CVVC.CV	37	1%	CVVC.CV	33	1%				CV.CVC	24	1%
									CCV.C:VC	27	1%	CVC.CVV.CV	30	1%				CV.CVC.CV	23	1%
									CVVC.CVC	26	1%	CVC.CV.CV	29	1%				CVVC.CVV	22	1%
												CCV.CVV	26	1%						
												CCV.C:VC	23	1%						
												CCV.C:V	20	1%						
Total	1,125			1,042			1,743			4,184			3,988			3,617			4,188	
No. shapes	35			40			51			140			111			149			159	
Geminates	189			58			176			500			557			299			361	

Note: Word shapes that occurred in less than 1% of total targeted words are not included in this table. Word shapes that contain at least one geminate are highlighted in grey.

Table A.2: Word tokens targeted by KA-speaking children

1;4-1;7	Word shape	Stress	no.	%	Gloss.
maːma	CVV.CV	Sw	62	6%	mum
koːra	CV.CV	Sw	57	5%	ball
haːðˤa	CVV.CV	Sw	55	5%	this + M
niˈjaːw	CV.CVVC	wS	46	4%	cat-sound
haˈjuːna	CV.CːVV.CV	wSw	43	4%	(name)
ʔiː	CVV		40	4%	yes
ʔaːna	CVV.CV	Sw	39	3%	me/I
guːl	CVVC		37	3%	you-say
haːðˤi	CVV.CV	Sw	33	3%	this + F
dbˤgi	CV.CV	Sw	30	3%	doggie
beːbi	CV.CV	Sw	30	3%	baby
hniː	CCVV		27	2%	here
laʔ	CVVC		22	2%	no
miːniː	CV.CːVV	wS	21	2%	here
baˌtˤˤa	CV.CV	wS	20	2%	duck
maɟ	CVVC		19	2%	water
haː	CVV		18	2%	what
ʔaj	CVVC		16	1%	ouch
zaˌjuːdi	CV.CːVV.CV	wSw	15	1%	(name)
maːw	CVVC		15	1%	cat-sound
ʕaːw	CVVC		15	1%	car-sound
laː	CVV		14	1%	no
tˤaːh	CVVC		12	1%	fell + M
fiːʧiː	CV.CːVV	wS	11	1%	open + F
faˌlaːh	CV.CVVC	wS	11	1%	(name)
diˈdiːd	CV.CːVVC	Sw	11	1%	car-sound
baːba	CVV.CV	Sw	11	1%	dad
dʊb	CVC		11	1%	bear
ʕaˌtˤˤiːni	CV.CVV.CV	wSw	10	1%	give me + F
daːdaː	CV.CVV	wS	10	1%	kid/child
ʔaːkil	CV.CVC	Sw	10	1%	food
ʃiːlf	CVCC		10	1%	chewing gum
bɔˌtˤˤaːtˤˤ	CV.CːVVC	wS	9	1%	chips
baːb	CVVC		9	1%	door
tˤɔˌfaːh	CV.CːVVC	wS	8	1%	apples
katˤkut	CVC.CVVC	wS	8	1%	chick
gatˤˤwa	CVC.CV	Sw	8	1%	cat
kaːhi	CVV.CV	Sw	8	1%	here it is + F
baːʕ	CVVC		8	1%	sheep-sound
ʔaːn	CVVC		8	1%	car-sound
ʕaˌtˤˤiː	CV.CVV	wS	7	1%	give it + F
ʔʌm	CVC		13	1%	food
kaː	CVV		7	1%	here
jaˌjˤa	CV.CːV	wS	6	1%	(name)
ˈmijaːw	CV.CVVC	Sw	6	1%	car-sound
Total*			1125		

1;8-1;11	Word shape	Stress	no.	%	Gloss.
ˈhaːðˤa	CVV.CV	Sw	152	15%	this + M
kinˌkong	CVC.CVCC	wS	62	6%	(name)
kaːhi	CVV.CV	Sw	47	5%	here it is + F
kuːku	CVV.CV	Sw	42	4%	(name)
ˈmaːma	CVV.CV	Sw	42	4%	mum
ʔaːbi	CV.CV	Sw	30	3%	I want
dʒanˌtˤˤa	CVV.CV	Sw	29	3%	bag
dʒuːti	CVV.CV	Sw	28	3%	shoe
laʔ	CVC		27	3%	no
kaː	CVV		24	2%	here it is
ʔiː	CVV		21	2%	yes
ˈhaːðˤi	CVV.CV	Sw	17	2%	this + F
beːbi	CVV.CV	Sw	17	2%	baby
taʔh	CVVC		17	2%	it fell + M
raʔh	CVVC		16	2%	he went + M
bɒːba	CVV.CV	Sw	15	1%	dad
ʔaːna	CVV.CV	Sw	14	1%	me/I
ʕaw	CVC		14	1%	dog-sound
haˌmaːma	CV.CVV.CV	wSw	13	1%	pigeon
daːdaː	CV.CVV	wS	13	1%	kid/child
ʔaːja	CVV.CV	Sw	13	1%	(name)
ʔaːbiːh	CV.CVVC	wS	11	1%	I want it + M
ˈmaːli	CVV.CV	Sw	11	1%	mine
haː	CVV		11	1%	what
weːn	CVVC		11	1%	where
ʕaˌtiːni	CV.CVV.CV	wSw	10	1%	give me + F
ʔeˌja	CV.CːV	wS	10	1%	(name)
diˈdiːd	CV.CːVVC	wS	9	1%	car-sound
maɟ	CVVC		9	1%	water
koˌra	CV.CV	wS	8	1%	ball
gaˌja	CV.CːV	wS	8	1%	(name)
ʔum	CVC		8	1%	dog-sound
beːt	CVVC		8	1%	house
ʕuˌmar	CV.CVC	Sw	7	1%	(name)
ɟuːf	CVVC		7	1%	look + M
ʔaːw	CVVC		6	1%	dog-sound
laː	CVV		6	1%	no
Total*			1042		

2;0-2;3	Word shape	Stress	no.	%	Gloss.
ˈhaːðˤa	CVV.CV	Sw	190	11%	this + M
ˈhaːðˤi	CVV.CV	Sw	109	6%	this + F
ʔiː	CVV		80	5%	yes
hniː	CCVV		56	3%	here
ʔaːbi	CV.CV	Sw	48	3%	I want
ʔaːna	CVV.CV	Sw	47	3%	me/I
miˌniːi	CV.Cː.CVV	wSw	44	3%	here
kaː	CVV		44	3%	(name)
ˈnuːnu	CVV.CV	Sw	43	2%	(name)
haː	CVV		43	2%	what
bisˌbis	CVC.CVC	Sw	39	2%	cat
ˈmɒːma	CVV.CV	Sw	39	2%	mum
diˌdiːd	CV.Cː.CVVC	wS	28	2%	car-sound
ˈbaːba	CVV.CV	Sw	28	2%	dad
maɟ	CVVC		27	2%	water
daˌdaː	CV.CVV	wS	24	1%	kid/child
kaˌhi	CVV.CV	Sw	24	1%	here it is + F
laʔ	CVC		24	1%	no
ʔifˌtˤah	CVC.CVCC	wS	21	1%	open + M
baːʕ	CVVC		21	1%	sheep-sound
miˌjaːw	CV.CVVC	wS	20	1%	cat-sound
kuːku	CVV.CV	Sw	20	1%	bird-sound
koˌra	CV.CV	Sw	18	1%	ball
diˌˈjaj	CV.CVVC	wS	15	1%	chickens
beːbi	CVV.CV	Sw	15	1%	baby
baˌrːni	CVVC.CVV	Sw	14	1%	(name)
baːˌbˤaːb	CV.CVC	wS	13	1%	bath
ˈmino	CV.CV	Sw	13	1%	who
ʔʌˌbɔː	CV.CVV	wS	12	1%	jump
goːl	CVVC		12	1%	goal
laː	CVV		12	1%	no
tˤaːh	CVVC		11	1%	fell + M
duːduː	CV.CVV	wS	10	1%	(name)
ˈdʒuːti	CVV.CV	Sw	10	1%	shoe
saˌmaːka	CV.CV.CV	wSw	9	1%	fish
ʔalˌʕaːb	CVC.CVVC	wS	9	1%	toys
weːn	CVVC		9	1%	where
Total*			1743		

Note: Words that occurred in less than 1% of total target words were excluded. Arabic gender markers (+M) and (+F) are added to English translation (gloss) columns.
*Total word count includes words that were targeted with frequency less than 1%.

Table A.2: Word tokens targeted by KA-speaking children

2;4-2;7	Word shape	Stress	no.	%	Gloss.
ˈha.ða	CVV.CV	Sw	219	5%	this + M
ˈha.ði	CVV.CV	Sw	104	2%	this + F
ba.ˈqa.ra	CV.CV.CV	wSw	55	1%	cow
ʃi.ˈnuː	CV.CVV	wS	55	1%	what
ˌkɔŋ.kɔŋ	CVC.CVCC	Sw	50	1%	(name)
ʔiː	CVV		45	1%	yes
tʃalb	CVCC		44	1%	dog
ˈʃu.fi	CVV.CV	Sw	41	1%	look + F
juːˈmaː	CV.CVV	wS	39	1%	mum
laʔ	CVC		38	1%	no
saˌjaːˈra	CV.CVV.CV	wSw	37	1%	car
haː	CVV		37	1%	what
hej	CVC		37	1%	this
ʔa.dri	CV.CCV	Sw	36	1%	I know
tɔ.ˈfaːh	CV.CVVC	wS	33	1%	apples
ˈkɔ.ra	CV.CV	Sw	33	1%	ball
ba.ˈtˤːa	CV.CːV	wS	32	1%	duck
ˈmɔ.ma	CVV.CV	Sw	32	1%	mum
ˈdʒib.na	CVC.CV	Sw	32	1%	cheese
sal.ˈhu.ˈfaːt	CVC.CV.CVVC	wwS	31	1%	turtle
tʃi.ˈðiː	CV.CVV	wS	31	1%	like this
xaːf	CVVC		31	1%	afraid
fiː	CVV		31	1%	in
ˈbɔː.ba	CVV.CV	Sw	30	1%	dad
ˈʔaː.na	CVV.CV	Sw	29	1%	me/I
ˈjaʕ.ni	CVC.CV	Sw	28	1%	it means
ˌsˤa.ger	CV.CVC	Sw	25	1%	eagle
gaʕ	CVVC		25	1%	doing
ˌʕasˤ.ˈfuː.ra	CVC.CVV.CV	wSw	24	1%	bird
fa.ˈraː.ʃa	CV.CVV.CV	wSw	24	1%	butterfly
ˌʕa.ˈwaː.ʃa	CV.CVV.CV	wSw	24	1%	(name)
ˈnaf.sa	CVC.CV	Sw	24	1%	like this + M
diˈjaːˌja	CV.CVV.CV	wSw	23	1%	chicken
ʔalˈʕaːb	CV.CCVVC	wS	23	1%	toys
xaˈlaːsˤ	CV.CːVVC	wS	21	1%	finish
ˈwha.ði	CCVV.CV	Sw	21	1%	and this + F
weːn	CVVC		21	1%	where
Total*			4184		

2;8-2;11	Word shape	Stress	no.	%	Gloss.
ˈha.ða	CVV.CV	Sw	193	5%	this + M
ˈha.ði	CVV.CV	Sw	84	2%	this + F
ˈʃi.nuː	CV.CVV	Sw	71	2%	what
ˈʔa.bi	CV.CV	Sw	67	2%	I want
kah.ˈra.ba	CVC.CV.CV	wSw	66	2%	electricity
xa.ˈliː	CV.CVV	wS	61	2%	leave it + F
baʕ.ˈdeːn	CVC.CVVC	wS	60	2%	after/then
ˌgatˤ.wa	CVC.CV	Sw	50	1%	cat
weːn	CVC		50	1%	where
dɔb	CVC		49	1%	bear
ˈʔa.sad	CV.CVC	Sw	48	1%	lion
ˈʔaː.na	CVV.CV	Sw	48	1%	me/I
maː	CVV		48	1%	not
sa.ˌjaːˈraː	CV.CVV.CVV	wSw	40	1%	car
tʃuː.ˈfaj	CV.CVC	wS	40	1%	look + F
ˈkɔ.ra	CV.CV	Sw	40	1%	ball
ˈdʒan.tˤa	CVC.CV	Sw	40	1%	bag
tɔ.ˈfa.ha	CV.CV.CV	wSw	36	1%	apple
tʃi.ˈðiː	CV.CVV	wS	36	1%	like this
haː	CVV		36	1%	what
ˈʔaz.rag	CVC.CVC	Sw	35	1%	blue
ba.ˈʕad	CV.CVC	wS	34	1%	more
laː	CVV		32	1%	no
kɔ.ˈwaː.la	CV.CVV.CV	wSw	31	1%	koala
weː.naː	CVV.CVV	Sw	31	1%	where is it +M
ʔiː	CVV		30	1%	yes
ˈma.bi	CV.CV	Sw	29	1%	I don't want
ra.h	CVVC		29	1%	he went
kaː	CV		26	1%	here it is
laʔ	CVC		25	1%	no
ʔiˌsa.wiː	CV.CV.CVV	wSw	22	1%	he does
ˈʔin.ta	CVC.CV	Sw	22	1%	you
ˈda.na	CVV.CV	Sw	22	1%	(name)
tˤeːr	CVVC		22	1%	bird
fiː	CVV		21	1%	in
tʃuːf	CVVC		21	1%	look + M
ʔaˈdɛːda	CV.CVV.CV	wSw	20	1%	grandma
sʌl.ˈhu.fa	CVC.CV.CV	wSw	20	1%	turtle
ˈʔar.nab	CVC.CVC	Sw	20	1%	rabbit
ˈma.ku	CVV.CV	Sw	20	1%	there isn't
Total*			3988		

3;0-3;3	Word shape	Stress	no.	%	Gloss.
ˈha.ða	CVV.CV	Sw	334	9%	this + M
ʔiː	CVV		84	2%	yes
ˈmaː.ma	CVV.CV	Sw	82	2%	mum
ʔɔː	CVV		79	2%	and
ʃi.nuː	CV.CVV	Sw	78	2%	what
ˈha.ði	CVV.CV	Sw	60	2%	this + F
ˈʔaː.na	CVV.CV	Sw	54	1%	me/I
ba.ˈʕed	CV.CVC	wS	45	1%	more
ba.ˈtˤːa	CV.CV	wS	37	1%	duck
fiː	CVV		36	1%	in
ˈtʃi.ðiː	CV.CVV	Sw	35	1%	like this
maː	CVV		35	1%	does not
ˈʔa.bi	CV.CV	Sw	33	1%	I want
si.ˈmatʃ	CV.CVC	wS	31	1%	fish
laʔ	CVC		28	1%	no
weːn	CVVC		27	1%	where
hniː	CCVV		25	1%	here
xa.ˈruːf	CV.CVVC	wS	23	1%	sheep
ˈgatˤ.wa	CVC.CV	Sw	23	1%	cat
ˈdʒuː.ri	CVV.CV	Sw	20	1%	(name)
ˈtʃuː.faj	CVV.CVC	Sw	20	1%	look + F
muː	CVV		20	1%	not
ˈmi.ðel	CV.CVC	Sw	19	1%	like
Total*			3617		

Note: Words that occurred in less than 1% of total target words were excluded. Arabic gender markers (+M) and (+F) are added to English translation (gloss) columns.
*Total word count includes words that were targeted with frequency less than 1%.

Table A.2: Word tokens targeted by KA-speaking children

3;4-3;7	Word shape	Stress	no.	%	Gloss.
ˈhaː.ða	CVV.CV	Sw	398	10%	this + M
ʔiː	CVV		124	3%	yes
maː	CVV		103	2%	not
ʃi.nːo	CV.CV	Sw	102	2%	what
ʔaː.na	CVV.CV	Sw	57	1%	me/I
bɪl	CVC		49	1%	in
laʔ	CVC		47	1%	no
ʔa.bi	CV.CV	Sw	45	1%	I want
laː	CVV		40	1%	no
ʧ̣ɪ.ˌðiː	CV.CVV	Sw	38	1%	like this
ʧalb	CVCC		35	1%	dog
jaː.ˌmaː	CV.CVV	wS	34	1%	mum
baʕ.ˌdeːn	CVC.CVVC	wS	33	1%	after/then
ˈgɛtˤ.wa	CVC.CV	Sw	33	1%	cat
bas	CVC		27	1%	only/just
kɔ.ra	CV.CV	Sw	26	1%	ball
ˈmaː.dri	CVV.CCV	Sw	26	1%	I don't know
ˈhaː.ði	CVV.CV	Sw	25	1%	this + F
waː.ˌhid	CVV.CVC	Sw	25	1%	one
leːʃ	CVVC		25	1%	why
haːj	CVVC		24	1%	this
sa.ˌjaː.ˌraː	CV.CVV.CVV	wSw	23	1%	car
ˈmaː.bi	CVV.CV	Sw	23	1%	I don't want
gaʕ	CVC		23	1%	doing
muː	CVV		23	1%	not
mi.ˌjaːw	CV.CVVC	wS	21	1%	cat-sound
Total*			4188		

Note: Words that occurred in less than 1% of total target words were excluded. Arabic gender markers (+M) and (+F) are added to English translation (gloss) columns.
*Total word count includes words that were targeted with frequency less than 1%.

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