Resyllabification in Standard Arabic: A Constraint-Based Approach

Mousa A. Btoosh, Fahad Bin Sultan University, Saudi Arabia

This study provides data-driven insights and analyses on lexical and post-lexical resyllabification in Standard Arabic within the framework of Optimality Theory. More particularly, the study is devoted to examining the impact of prosthesis, voweled letters, affixation, and vowel epenthesis and shortening on resyllabification processes within words and across word boundaries. Results show that Standard Arabic typically makes use of prothesized non-phonemic segments, voweled letters and epenthesis to avoid inadmissible clusters. Findings also reveal that in certain cases this variety shortens long vowels to avoid lexical and post-lexical trimoraic syllables. Moreover, the data provided have well proven that complex codas resulting from the deletion of word-final short vowels or nunation utterance finally do not often adhere to the Sonority Sequencing Principle.

Keywords: *Standard Arabic, constraints, resyllabification, lexical, post-lexical*

1. Introduction

Grouping and organizing successive sounds into effective entities such as syllables is not a new idea as commonly thought of. Rather, this notion dates back to the momentous reconstruction of the behavior of Indo-European sonants in the 19th century (Goldsmith 2011: 1). A similar but more explicit reference to syllables is found in Erdmann & Dodge (1898: 185)'s attempt to examine the psychological process of reading. Based on the findings of this experimental study, the authors argue "...we never find a letter-to-letter reading process in the sense that attention is paid to individual letters in succession. In this case, the reading process rather operates on letter groups of different extent which are organized into speaking syllables or other 'grammatical groups of letter sounds." Nonetheless, the concept of syllable wasn't used in its current sense until the mid-1950s and the dawn of the generative phonology age launched by Chomsky & Halle (1968). On the whole, this era witnessed unprecedented advancement on the research theories and methodological approaches employed in the study of phonology.

Despite the lack of a consensus on not only the syllable-internal structure but also on whether or not the abstract notion of syllable has a phonetic correlation (cf. Yip 2002; Kenstowics 1994), research on prosody shows that there has been an increasing interest in the role a syllable can play towards a better understanding of phonological representation and analysis. For Haugen (1956: 216), syllable is "the most convenient framework for describing the distribution of phonemes." Fudge (1965) points to the significant role of syllable as a unit of phonological analysis. Bolinger (1975: 56) argues that the syllable owes much of its obviousness to the role it plays in rhythm. Liberman et al. (1974) contend that syllables are the first linguistic units that appear in the course of language acquisition. For Mehler (1981), syllable is the most important prelexical level of representation.

In addition to its significant role in phonological representation and analysis, syllable has shown an ever-increasing powerful presence and dominant capacity in accounting for various phonological phenomena. More particularly, syllable forms the basis of many phonological processes such as prosthesis, syncope, apocope, degemination, epenthesis, and vowel shortening and lengthening; these alternations or processes, which depend on the syllable structure in a word, occur in order to avoid the surfacing of marked syllable structures. All the more, syllable has shown exceptional capabilities in accounting for three approaches that dominated the phonological scene during the past six decades.

Goldsmith (2011) points to three generalizations on syllable structure that were modeled into three approaches, namely, the sonority approach, the syntax-based immediate constituent approach and the finite-state approach. The sonority approach "is based on the view that each segment in an utterance has a sonority value, and that there are crests and troughs, or peaks and valleys of sonority in the speech chain, with peaks coinciding with vowels and syllable nuclei, and troughs coinciding with boundaries between syllables" (2011: 166). Accordingly, the nucleus elements are more sonorant than the marginal ones. The rises and falls in the sonority of an utterance give insights on whether or not the consonants are in the onset or in the coda. So, consonants that appear in a context of rising sonority occupy the onset position while the ones with falling sonority appear at the end of a syllable. Unlike the sonority approach, the syntax-based immediate constituent approach, which uses phrase structure rules to describe possible sequences, itemizes the constituents of structure. The third approach, on the other hand, is devoted to the permissible sequences in a language. Thus, it appears that the importance of the syllable stems from the roles it plays in phonological generalizations including phonotactic patterns, phonological processes, suprasegmentals and syllabification.

World languages considerably diverge with regard to their syllable types. Some (such as Hawaiian) allow just simple syllable structures while most others permit more complex ones (e.g. English and Arabic) (Davis 2002). Yet, irrespective of the permissible syllable structure in a language, it should be made obvious that organization of segments into syllables is governed by the well-formedness notion, which is, in turn, constrained by universal principles. This, of course, should not by any means conceal the existence of language variations, which are accounted for by language-specific rules or different rankings of universal constraints as proposed by Optimality Theory (OT, henceforth).

The emergence of OT, whose tenets were laid out by Prince & Smolensky (1993) and McCarthy & Prince (1993), led to the evolvement of several methodological and linguistic assumptions. Consequently, many of the doctrines and principles previously dominating the linguistic scene were changed and others came into prominence. For instance, language-specific rules have been replaced by universal constraints, where just constraint rankings are language particular. Also, a constraint violation within the OT framework does not render the form ungrammatical as it was the case under the umbrella of the earlier approaches. Moreover, the inviolable linear rules were replaced with violable hierarchically organized constraints. Still more, all candidates are considered in parallel. So, OT features no repairs and no step-by-step derivations (Kenstowics 1994).

Based on the OT principles, the choice of the winner or optimal candidate depends on the satisfaction of the higher-ranked constraints. However, in a more recent account, constraint ranking and parallel evaluation of the OT (Prince & Smolensky 1993) were challenged by the Harmonic Grammar and Harmonic Serialism theories (McCarthy & Pater 2016); based on the tenets of these theories, constraints are weighted rather than ranked and multiple violations of the lower-ranked constraints outrank a violation of the higher-ranked ones.

Irrespective of the variations between the two competing versions, the selection of the optimal candidate is governed by structural and faithful sets of constraints. Structural constraints favor the unmarked forms over the faithful ones while faithfulness constraints favor the true-blue ones.

This study uses a constraint-based approach (Prince & Smolensky 1993) to investigate lexical and post-lexical resyllabification in SA. To this end, the study incorporates mappings between the input and output of phonological and morphological elements. It also involves an investigation into and accounting for the impact of the voweled letters, epenthesis and deletion of the non-phonemic segments, assimilation of the definite article /l/ to the following coronal consonant, and vowel shortening on lexical and post-lexical resyllabification processes.

2. Standard Arabic: An overview

SA refers to the High and ancient variety of written Arabic codified and recorded by Arab grammarians and philologists at the dawn of Islam. This variety is very rich in terms of inflections, where mood, case, number, gender, and most grammatical functions are marked by short vowels. It also distinguishes between three numbers (singular, dual and plural) and is almost completely uniform across the Arab world (Zughoul 1980). Like other languages, SA has constraints that govern the number, type and arrangement of sounds in syllables. Despite the variations among languages in this regard, it is crucial to highlight that the distribution of sounds in SA is, to a large extent, governed by universal tendencies and principles rather by than language-specific rules, as clarified through the examples given below.

As far as syllable types are concerned, six canonical patterns have been attested in SA; these types include: CV, CVC, CVV, CV(X)C, CVVCC. Unlike English, the onset node is obligatory in SA. Nonetheless, underlyingly branching onsets are banned from surfacing in this variety. As far as the nucleus is concerned, SA does not allow more than two slots linked to a monophthong or diphthong. Coda, on the other hand, is optional and ranges from zero to two sounds. Based on the illustrative examples below, branching codas are permissible just in utterance-final positions.

(1)

a. CV	shariba /ʃa.ri.ba/	'he drank'
b. CVC	yal^c^abu /jal. ʕa.bu/	'he is playing/plays'
c. CVV	qa:la /qa:.la/	'he said'
d. CVVC	ja:r# /dʒa:r/ ma:t# /ma:t/	'neighbor' 'he died'
e. CVCC	sarj# /sardʒ/	'saddle'
f. CVVCC	^c^a:mm# /ʕa:mm/	'general'
g. CVCC	sadd# /sadd/	'dam'

Unlike the first three syllable types, which can occur in any position, the fourth type (CVVC) may occur word internally or in a pre-pause position as a result of the deletion of word-final short vowel or nunation utterance-finally. The occurrence of other patterns (CVCC, CVVCC, and CVC_XC_X where C_XC_X stands for geminate consonants) is apparently restricted to a pre-pause position as a result of the deletion of word-final short vowels or nunation utterance finally. A close look at the examples in (2) below shows that consonant clusters resulting from the deletion of the word-final short vowels or nunation are permissible irrespective of whether or not such clusters result in a violation of the Sonority Sequencing Principle (SSP, henceforth).

(2)

a. CVCC	fajr#	/fadʒr/	‘dawn’
c. CVCC	haml#	/ħaml/	‘pregnancy’

Based on the principles of metrical phonology and weight, SA distinguishes between four types of syllables. A syllable with a non-branching nucleus and rime is light (CV) while the one with a branching nucleus or rime (CVC and CVV) is heavy. A syllable with a branching nucleus or coda (CVVC or CVCC) is superheavy whereas the one with a branching nucleus and coda (CVVCC) is extra superheavy.

Since the second half of 1960s, Arabic varieties have been a subject of ongoing research. Much of the research on Standard and dialectal Arabic has been devoted to major phonological aspects related to syllable structure, sonority scale, stress placement, syllable weight, syncope, apocope, and syllabification (Abdo 1969; Al-Ani 1970; Brame 1970; McCarthy 1979; Abu-Salim 1982; Alghazo 1987; McCarthy & Prince 1990; Abu Mansour 1995; Adra 1999; Mobaidin 1999; Watson 2002; Abuabbas 2003; Btoosh 2006; Dickins 2007; Rakhiya 2009; Al Tamimi & Al Shboul 2013; Youssef 2013; Heselwood & Watson 2013; Al Mashaqba 2015; Hwaidi 2016; Btoosh 2018, to name just a few). A careful examination of such studies shows that Arabic varieties diverge considerably with regard to syllable structures, syllable-based phonological processes and syllabification.

Like other Arabic varieties, SA does not allow for onsetless syllables. Yet, it still varies from other varieties in terms of the branching onset. That is, branching onsets, which are admissible in many Arabic varieties, are impermissible in SA. As far as the nucleus and coda are concerned, SA exhibits some common features with almost all other Arabic varieties. For instance, a nucleus dominates no more than two timing slots linked to a monophthong or a diphthong. Likewise, a coda may dominate up to two slots linked to consonants or glides.

3. Syllabification and resyllabification in SA

Despite the phonotactic variations among languages, syllabification, the process of dividing a word into its constituent syllables, is constrained by numerous universal principles. Chief among them are the Legality Principle, SSP, and Maximum Onset Principle. The Legality Principle constrains the types and number of segments that can begin and end syllables. Put differently, segments to the left and right of the nucleus are subject to language-specific rules (Steriade 1999; Goslin &

Frauenfelder 2001). However, this principle has a serious shortcoming as it is unable to impose a sole syllabification algorithm. For instance, the word *security* could be syllabified as [sə.ˈkjʊ.rə.ti], [sək.jʊ.rə.ti] or [sə.ˈkjʊr.ə.ti] since this principle imposes restrictions on the segments that can be tolerated in the onset or coda positions, but unable to provide the appropriate parsing of segments into syllables.

The universal phonotactic principle ‘SSP’, on the other hand, governs the permissible sequences of consonants within syllables in terms of sonority. Accordingly, syllable-initial consonants must rise in sonority while codas fall in sonority. Yet, it should be reiterated that languages’ adherence to the SSP is never absolute. Thus, it seems apparent that both Legality and Sonority Sequencing principles are meant to dictate the permissible onsets and codas in a language. Yet, neither one adequately provides instructions on the optimal parsing of syllable-boundary segments into syllables.

Unlike the Legality Principle and SSP, which have failed to adequately account for the parsing of syllable-boundary segments into syllables, the Maximum Onset Principle displays exceptional and straightforward abilities in this regard. Based on this principle, intervocalic consonants are maximally assigned to the onsets of syllables in conformity with universal and language-specific conditions. However, appropriate syllabification of segments requires the involvement of several other universal constraints as well.

Within the OT framework, syllabification is governed by two sets of constraints. Faithfulness constraints ban any change of the input structure while well-formedness (markedness) constraints enforce input modification so as to avoid marked structures. So, syllable types that surface in a language emanate from the interaction between well-formedness and faithfulness constraints pertaining to syllable structure (Kager 2004).

Based on Comrie (2006), markedness of a construction is determined by its regularity, stability, and centrality to the core of a particular language as well as by cross-linguistic generalizations about construction types. According to this study, there are several markedness criteria, including frequency, complexity, and distribution. So, markedness constraints are devoted to evaluating output well-formedness and banning (the surfacing of) all marked features, segments and structures.

An extensive review of the onsets in SA shows that any consonant can occur as an onset either word-initially or word-internally. It is also important to reiterate that complex onsets are disallowed in this variety. As a consequence, SA, like all other Arabic varieties, resorts to epenthesis or resyllabification in order to avoid the surfacing of onsetless syllables or complex onsets. So, the interaction between faithfulness constraint (DEP-IO), which requires correspondence between input and output, and markedness constraints (ONSET) and *COMPLEX^{ONS}, ends in favor of the last ones, as shown in Table (1). However, any attempt to introduce a new syllable by inserting a vowel inside the root morpheme will render the candidate suboptimal as it fatally violates the M-O-CONTIG constraint, which prevents morpheme internal epenthesis.

(3) ONSET

*[σ V ‘Syllables must have onsets.’ (Prince & Smolensky 1993)

(4) NOCODA

*C]σ (‘Syllables are open.’) (Kager 2004)

(5) DEP-IO

Every segment in the output has a correspondent in the input (McCarthy & Prince 1995)

(6) * COMPLEX^{ONS}

*[σ CC (‘Onsets are simple.’) (Kager 2004)

(7) M-O-CONTIG ("No M-internal insertion")

The portions of the output standing in correspondence and belonging to the same M form contiguous strings - Where M ∈ {morpheme, stem} (Landman 2003)

(8) Input: /bnah/ ‘daughter’

Table 1: ONSET, *COMPLEX^{ONS}, M-O-CONTIG >> NOCODA, DEP-IO

/bnah /	ONSET	*COMPLEX^{ONS}	M-O-CONTIG	NOCODA	DEP-IO
a. /bnah/		*!			
b. /ib.nah/	*!				*
c. ☞/?ib.nah/					**
d. /?i.bnah/		*!		*	**
e. bi.nah			*!	*	*

Being faithful to the input inevitably entails a violation of *COMPLEX^{ONS} since branching onsets are disallowed in SA. This violation constitutes the sole reason for the elimination of candidate (1a). Irrespective of whether or not it has an onset underlyingly, the ONSET constraint strictly stipulates that under no circumstances can an onsetless syllable surface in this variety. This justifies the immediate elimination of the second candidate. So, the epenthesis of the short vowel with the aim of avoiding the fatal violation of *COMPLEX^{ONS} results in ultimate failure since ONSET and *COMPLEX^{ONS} are not ranked with each other. Candidate (1c) illustrates a successful attempt to satisfy the *COMPLEX^{ONS} constraint through the epenthesis of elidable non-phonemic segments consisting of a glottal stop followed by a high short vowel. By resyllabifying the first consonant in the impermissible consonant clusters as the coda of the epenthetic nucleus [i], the third candidate emerges as optimal in spite of incurring a double violation of the low-ranked faithfulness constraint DEP-IO. An input containing consonant clusters word- or syllable-initially will never be able to surface owing to the violation of the higher ranked *COMPLEX^{ONS}, which is responsible here for ruling out candidate (1d). The last candidate, on the other hand, is excluded as a result of the insertion of a high short vowel inside the root morpheme. Though candidate (1c), the optimal, shares with candidate (1e) the violation of the low-ranked constraint DEP-IO, it is the epenthesis locus that makes the difference between them. That is, morpheme external insertion (at left edge or morpheme juncture) is allowed while morpheme-internal epenthesis is not. This elucidates that morpheme internal insertion in (1e) has constituted a serious breach of the top-ranked constraint M-O-CONTIG and led to the elimination of this candidate from the race.

In the context of the non-phonemic epenthetic segments (/?/ and /V/, where V means a 'vowel'), traditional Arabic grammarians distinguished between two types of hamza 'glottal stop' (Ryding 2005). The first type is called hamzatul qati[c], 'non-connecting or non- elidable glottal stop' while the second one is known as 'hamzatul wasl', the connecting or elidable glottal stop. The non-elidable glottal stop, which is also known as the strong glottal stop, is phonemic and occurs word initially, medially and finally. Having known that no Arabic word can begin with a vowel, then it is obligatory that the word-initial ?*alif (long vowel: aa)* needs to be always a seat for glottal stop in order to avoid onsetless syllables. In Arabic orthography, the non-elidable glottal stop is placed over the ?*alif* (أ) if it is followed by *fatħa* (*a*) or *ḏˁammah* (*u*), and under the ?*alif* (إ) if it is followed by *kasrah* (*i*).

However, the elidable non-phonemic epenthetic glottal stop /?/, which occurs when a word begins with a consonant-cluster, does not show up above or below the '?alif'. Rather, it is a superscript *saad* (diacritic) drawn above a line (ٱ). It appears rather apparent from the example below that epenthetic segments (/?/ and /V/) are triggered only to avoid the surfacing of the underlyingly consonant-clusters word-initially, as shown in (9).

(9) /nkasar-a/ ⟶ ?in.ka.sa.ra 'it broke'

The glottal stop, along with the following high short vowel, is epenthesized here since it is impermissible in SA to start with a non-voweled consonant as this leads to the surfacing of a complex onset. Consequently, this glottal stop, together with the vowel that follows, is elided when preceded by a voweled letter (when joined to the preceding word). This explains the deletion of the epenthetic segments (/?/ and /V/) when the ONSET and/or COMPLEX^{ONS} are satisfied.

(10) #wa# #?inkasar-a# ⟶ /wan.ka.sa.ra/ 'and it broke'

However, when the non-elidable glottal stop is used in the same phonetic environment, the glottal stop, together with the following vowel remains unaffected, as it is part of the input rather than an epenthesized one. A simple example to show this is given in (11).

(11) /wa + ?aħmad-u/ ⟶ /wa.?aħ.ma.du/ 'and Ahmad'-Nom.

3.1 *Resyllabification within words*

Satisfaction of the ONSET constraint does not always necessitate epenthesis. On the contrary, SA resorts to epenthesis only when other choices fail to work. Therefore, this explains the resort of SA to resyllabification rather than epenthesis to avoid the surfacing of onsetless syllables, as illustrated in Table (2). Based on the examples below, resyllabification, a phonotactically-motivated repair process, is applied cyclically when a vowel-initial suffix is added. Therefore, resyllabifying the last member of the coda as an onset of the following vowel-initial syllable will result in a clear breaching of ALIGN (R).

(12) ALIGN (R)

'Align root morpheme boundaries with syllable boundaries at both edges.' (Yip 1994)

(13) Input: /kalb+an/ ‘a dog’ (accusative)

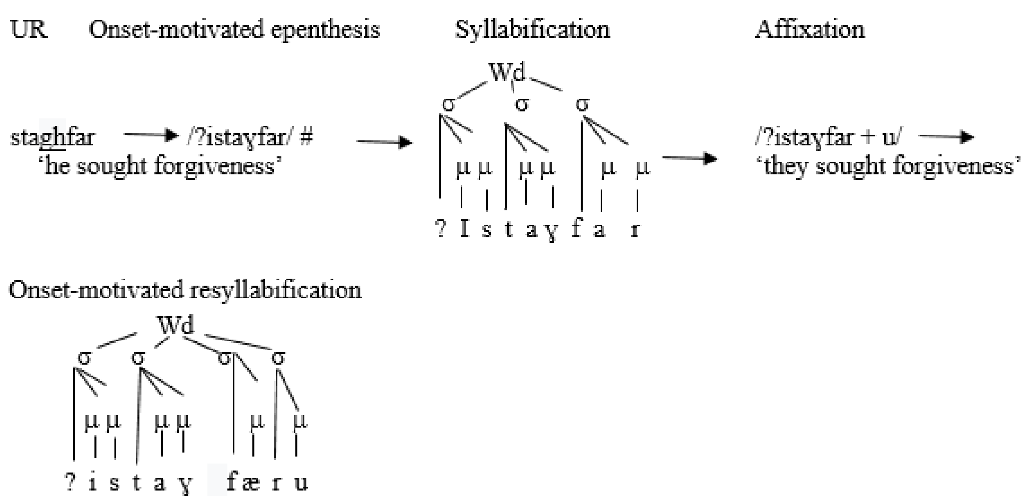
Table 2: ONSET, *COMPLEX^{ONS}, M-O-CONTIG >>DEP-IO, NOCODA’ ALIGN (R)

#kalb#+#an#	ONSET	*COMPLEX^{ONS}	M-O-CONTIG	DEP-IO	NOCODA	ALIGN (R)
a. /kalb.an/	*!					
b./ka.lban/		*!			*	*
c. ☞/kal.ban/						*
d. /ka.li.ban/			*!	*	**	*

The first candidate is rejected on account of its violation of the markedness constraint ONSET, which prevents onsetless syllables from surfacing. Despite satisfying ONSET, the second candidate is ruled out due to incurring a violation of the markedness constraint *COMPLEX^{ONS}. The optimal candidate (2c), on the other hand, wins the race by accomplishing a total satisfaction of all constraints except for the rightmost (lowest-ranked) one ALIGN (R). In spite of being in complete harmony with the top-ranked markedness constraints (ONSET and *COMPLEX^{ONS}), the last candidate is eliminated as it fatally violates the top-ranked faithfulness M-O-CONTIG constraint.

In addition to the onset-motivated resyllabification process, SA resorts to onset-motivated epenthesis when a word begins with a non-voweled letter. The structure in (14), which is the outcome of applying resyllabification cyclically, presents examples of both onset-motivated resyllabification and onset-motivated epenthesis processes. Onset-motivated epenthesis is triggered by the complex onset, which is banned in this variety. Consequently, the first element of the complex onset is resyllabified as a coda of the epenthetic CV (where C refers to the glottal stop and V to the high short vowel). Onset-motivated resyllabification, on the other hand, is triggered by the newly formed onsetless syllable resulting from affixation [-u].

(14)



The question that arises here is whether or not it is permissible to break the CC cluster in the underlying form above ‘staghfar’ by just changing the epenthesis locus. That is, to break such as a cluster by inserting a high short vowel between C_1 and $C_{2.,}$ (si.tagh.fa.ru). While this choice seems less costly than epenthesizing the two other segments (/?/ and /v/), it still remains not the right choice as the resulting output form is ruled out by the M-O-CONTIG constraint.

(15) Input: /staɣfar+u/ ‘they (m.) sought forgiveness’

Table 3: ONSET, *COMPLEX^{ONS}, M-O-CONTIG >> NOCODA, DEP-IO, ALIGN (R)

/staɣfar+u/	ONSET	*COMPLEX ONS	M-O-CONTIG	NOCODA	DEP-IO	ALIGN (R)
a. /is.taɣ.fa.ru/	*!			**	*	*
b.☞/?is.taɣ.fa.ru/				*	**	*
c. /staɣ.fa.ru/		*!		**		*
d. /si.taɣ.fa.ru/			*!	***	*	*

The grammar of this variety vehemently rejects onsetless syllables and consistently gives onsets priority over codas. Accordingly, VCCV and VCV are always syllabified as VC.CV and V.CV, respectively. Thus, the first candidate loses the competition as it commits a fatal violation of the top-ranked constraint ONSET. The optimal output (3b) violates the lowest-ranked constraints NOCODA, DEP-IO and ALIGN (R). No doubt, the violation of these constraints is necessary for this candidate in order to avoid the penalty of the higher-ranked constraints ONSET and *COMPLEX^{ONS}. That is, via the resyllabification of the onset [s] as the coda of the epenthetic nucleus [i], candidate (3b) could break up the inadmissible consonant clusters and steer clear of the penalty of the top-ranked constraint *COMPLEX^{ONS}. Also, this candidate could avoid incurring a violation of the undominated ONSET by resyllabifying the coda of the underlying penultimate syllable as the onset of the ultimate syllable. Though it fully satisfies the undominated ONSET, candidate (3c) is excluded by *COMPLEX^{ONS}. In spite of being in full compliance with the two top constraints ONSET and *COMPLEX^{ONS}, the last candidate is ruled out by M-O-CONTIG, which bans morpheme medial epenthesis.

Epenthesis in SA is not restricted to the non-phonemic segments, as shown above. Rather, it is also used to avoid the surfacing of impermissible consonant clusters, which result in trimoriac syllables or a complex onset. For instance, the emphatic form of the imperfect verb *yadrus* ‘he studies’ is formed by suffixing the syllable –nna to the root morpheme /ja+drus+nna/. For that reason, epenthesizing a low short vowel in the example below seems inescapable to avoid having a trimoraic syllable.

(16) *3μ
(‘No trimoraic syllables’) (Kager 2004)

(17) Input: /jadrus+nna/ ‘he studies/most certainly will study’

Table 4: *COMPLEX^{ONS}, *3μ, M-O-CONTIG>> NOCODA, DEP-IO, ALIGN (R)

#jadrus#+#nna#	*COMPLEX^{ONS}	*3μ	M-O-CONTIG	NOCODA	DEP -IO	ALIGN (R)
a. /jad.rusn.na/		*!		*		*
b. /jad.rus.nna/	*!			*		
c. ☞/jad.ru.s**a**n.na/				**	*	*
d. /ja.di.rus.nna	*!		*	***	*	

The first candidate is eliminated by the *3μ constraint as syllables are maximally bimoraic. Candidate (4b) fatally violates *COMPLEX^{ONS}, which is undominated in this variety. In spite of violating the low ranking constraints NOCODA, DEP -IO and ALIGN (R), the third candidate, emerges as optimal simply by both epenthesizing a low short vowel [a] to break the impermissible consonant clusters [-nna] and resyllabifying the first member of the suffix [-nna] as a coda of the epenthetic nucleus. By so doing, this candidate could avoid the penalty of the high-ranking constraints. A comparison between candidates (4c) and (4d) reveals that M-O-CONTIG bans epenthesis morpheme internally, but not at morpheme juncture. This explains the elimination of the last candidate. Though it is beyond the scope of this paper, the type of the epenthetic vowel (*i*, *a*, or *u*) in Arabic varieties, in general, is primarily governed by the position of the cluster (initial or medial), definite article, and verb pattern.

In addition to epenthesis, SA sometimes resorts to vowel shortening to avoid non-final inadmissible syllable structures. For instance, the long vowel in CVVC syllables in verbs such as *yakha:f* 'he fears' in Table (5) below is reduced when suffixed with the plural feminine morpheme –na. It seems obvious from the constraint interactions below that SA prefers adhering to *3μ over breaching MAX-V-IO. Also, this variety imposes severe restrictions on non-final light syllables.

(18) MAX-V-IO

Input vowels must have output correspondents. ('No vowel deletion.') (Kager 2004)

(19) REDUCE

Minimize the number of non-final light syllables. (Kiparsky 2003)

(20) Input: /jaxa:f+na/ 'they (f.) fear'

Table 5: *COMPLEX^{ONS}, *3μ, REDUCE >> DEP-IO, MAX-V-IO, NOCODA, ALIGN (R)

#jaxa:f#+#na#	*COMPLEX^{ONS}	*3μ	REDUCE	DEP-IO	MAX-V-IO	NOCODA	ALIGN (R)
a. /ja.xa:f.na/		*!				**	
b. /ja.xa:.fna/	*!		*			***	*
c. ☞/ja.xaf.na/			*		*	**	
d. /ja.xa:.fa.na/			**!	*		****	*

Candidate (5a) preserves all the input segments. Nevertheless, it is entirely taken out of the race by *3μ, which strictly stipulates that a syllable is maximally biomoraic. Adjoining the last consonant of the root to the following syllable successfully helps the second candidate avoid the penalty of *3μ. But still, this attempt has rendered candidate (5b) suboptimal as it fatally violates *COMPLEX^ONS. Candidate (5c) turns up the optimal output by managing to escape the penalties of both *COMPLEX^ONS and *3μ via deleting the input segment [a] and parsing the suffix as a separate syllable. Though it is in harmony with the *3μ, the last candidate is eliminated due to the double violation of the REDUCE constraint, which disfavors non-final light syllables. Although both (5c) and (5d) violate REDUCE, the former is selected since it minimally violates REDUCE. That is, (5c) has only one violation while its contestant (5d) incurs two violations.

3.2 *Resyllabification across word boundaries*

Resyllabification in Arabic varieties, including SA, is applied post-lexically as well. It is worth mentioning that post-lexical resyllabification is common in all colloquial Arabic varieties, which mainly resort to epenthesis to break impermissible consonant clusters. However, the case is substantially different in SA as the last consonant is almost always voweled unless in pre-pause position as a result of the deletion of word-final short vowel utterance-finally. Drawing on cross-sectional analysis of the data below, it clearly emerges that the definite article in Arabic constitutes a major phonological domain for resyllabification.

In the context of the definite article in Arabic, it is essential to mention that this article consists of just one segment /l/, called '*la:m atta*ᶜ*ri:f*' (the definite article). However, since complex onsets cannot surface in Arabic, then the addition of the definite article to a noun (or an adjective) always results in banned consonant clusters (Gadoua 2000). For this reason, a new syllable consisting of a glottal stop followed by a short vowel is inserted before the /l/, as shown in (21).

(21)	Indefinite Noun	UR Definite Noun	SR Definite Noun	Gloss
	ba:b	l-ba:b	?al.ba:b	'the door'
	ᶜalam	l-ᶜalam	?al.ᶜalam	'the flag'

When the definite article */l/* is followed by sun (or solar) letters, coronal consonants, it (*the definite article 'l')* completely assimilates to the following noun or adjective's initial consonant. As such, the following sun letter becomes a geminate, as shown in (22).

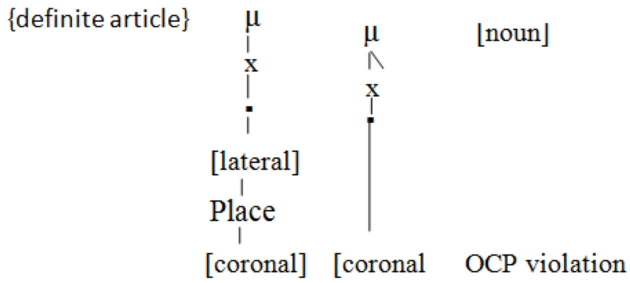
(22) a. ?al-shams-u > /?aʃ.ʃam.su/ 'the sun' (NOM)
b. ?al-da:r-u > /?ad.da:.ru/ 'the house' (NOM)

It is noticeable that both the definite article [l] and the following sun letter share the same feature, viz., [+cor], consequently violating the Obligatory Contour Principle (OCP).

(23) OCP
At melodic level, adjacent identical elements are prohibited. (McCarthy 1986)

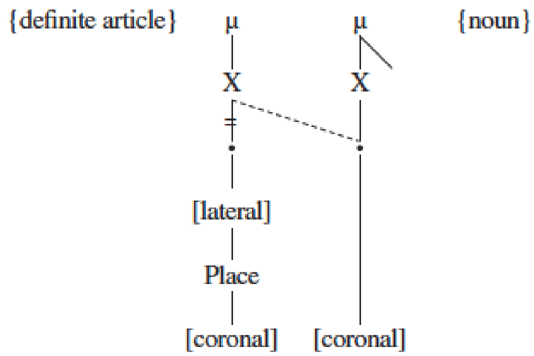
Watson (2002: 220) depicts OCP violation, as in (24).

(24)



The assimilation of the definite article /l/ to the following coronal triggers the violation of the OCP on the coronal tier. To overcome this dilemma, Watson (2002: 220) notionally represents the assimilation of –l to the following coronal, as shown in (25).

(25)



Based on this representation, the leftmost root node is deleted and the rightmost node spreads to the left node. It is noticeable from the representation in (25) that the two adjacent different segments end up in identical segments (geminates). Irrespective of the violations incurred against IDENT-IO (αF), the newly formed geminate is in absolute harmony with the OCP, [LAT COR] SHARE (F), and MAX-C-IO constraints.

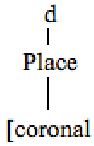
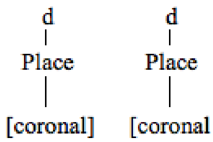
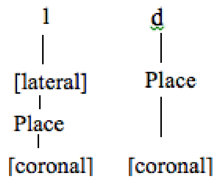
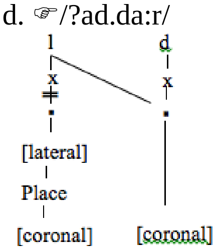
(26) IDENT-IO (αF)
Output correspondents of an input [αF] segment are also [αF] (McCarthy & Prince 1995: 264).

(27) [LAT COR] SHARE (F)
Across a morpheme boundary, /l/ and the following coronal consonant should be assigned the same token features (McCarthy 2010)

(28) MAX-C-IO
'Input consonants must have output correspondents. ('No consonant deletion.' (McCarthy & Prince 1995)

(29) Input: /l-da:r/ 'the house'

Table 6: OCP, [LAT COR] SHARE (F), MAX-C-IO, *COMPLEX^ONS >> DEP-IO, IDENT-IO (αF)

/l-da:r/	OCP	[LAT COR] SHARE (F)	MAX-C-IO	*COMPLEX^ONS	DEP-IO	IDENT-IO (αF)
a. /?a.da:r/ 			*!		**	
b./?a.dda:r/ 	*!			*	**	*
c. /?al.da:r/ 	*!	*			**	
d. ☞/?ad.da:r/ 					**	*

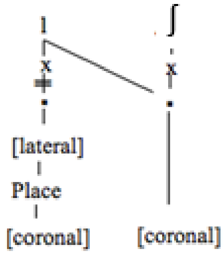
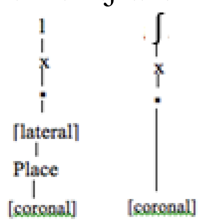
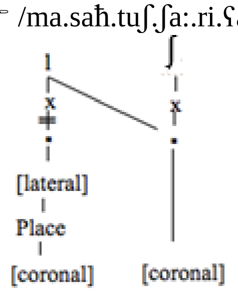
By deleting the definite article *[l]*, candidate (6a) fully satisfies *OCP, but to no purpose since it has incurred a fatal violation of the MAX-C-IO. Avoiding the pitfall of the first candidate has not been sufficient to prevent candidate (6b) from being ruled out by *COMPLEX^ONS, which bans branching onsets. Also, this candidate is less harmonic than candidate (6a) with respect to the top-ranked OCP constraint. Despite attempting to be quite faithful to the input form, candidate (6c) is excluded as it breaches the top-ranked constraints OCP and [LAT COR] SHARE (F). The optimal candidate (6d) incurs a double violation of DEP-IO and a single violation of IDENT-IO (αF). Yet, such violations are least expensive and necessary to escape the penalty of the left-most top-ranked constraints.

Post-lexical resyllabification, which is common in all Arabic varieties, merely creates an environment where word boundaries and syllable boundaries do not coincide. This will unquestionably always lead to the violation of ALIGN (W) constraint, as shown in Table (7).

(30) ALIGN (W)
‘Align the right edge of a word with the right edge of a syllable.’ (Harris & Gussmann 2003)

(31) Input: /#masaħt-u# #l-ʃa:riʕ-a# ‘I wiped the street’

Table 7: OCP, [LAT COR] SHARE (F), ONSET, *3μ, MAX-C-IO >> IDENT-IO (αF), ALIGN (W)

#masaħt-u# #l-ʃa:riʕ-a#	OCP	[LAT COR] SHARE (F)	ONSET	*3μ	MAX-C-IO	IDENT-IO (αF)	ALIGN (W)
a. /ma.saħ.tuʃ.ʃa:r.i.ˤa/ 			*!	*		*	*
b. /ma.saħ.tul.ʃa:.ri.ʕa/ 	*!	*					*
c. ☞ /ma.saħ.tuʃ.ʃa:.ri.ʕa/ 						*	*
d. /ma.saħ.tu.ʃa:.ri.ʕa/ 					*!		*

In spite of its full compliance with the OCP, the first candidate commits two fatal violations against ONSET and *3μ. It should be made plain that the last consonant in superheavy syllables (CVC, CVCC and CVVC) is extrasyllabic or invisible word-finally since the last consonant in these types of syllables is always extrametrical. So, having a trimoraic syllable always renders the syllable inadmissible. By parsing the [r] as the onset of the following syllable candidate (7b) successfully avoids the penalty of both ONSET and *3μ. But this attempt has been proven to be of no avail since this candidate is ruled out by the top-ranking constraints OCP and [LAT COR] SHARE (F). Candidate (7c) wins over other candidates (which violate the higher-ranked constraints) as it has successfully satisfied all the leftmost ranked constraints. The last candidate is discarded by MAX-C-IO since consonant deletion is not tolerated in this variety.

Unlike sun letters, where the definite article [1] loses its distinctive features and is assimilated to the initial consonant of the following noun or adjective, the definite article retains all its features when followed by moon (or lunar) letters. As such, by being non-coronals, the definite article [1] does not assimilate to the following moon letters, as shown in (32).

(32)

a. l-qamar-u > /?alqamar –u/ ‘the moon (NOM)

b. l-ba:b-u > /?alba:b-u/ ‘the door’ (NOM)

Drawing on (32), the definite article retains its input features when followed by a non-coronal sound; the input features of the definite article /l/ are preserved by IDENT-IO (PLACE).

(33) IDENT-IO (PLACE)

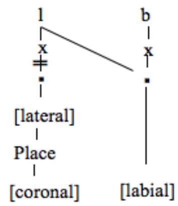
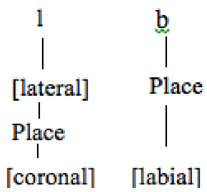
Correspondents in input and output have identical place features. (Kager 2004)

It is evident from Tables (7) and (8) that resyllabification takes place post-lexically irrespective of whether the following noun (or adjective) starts with a sun or moon letter. A comparison between the two examples shows that except for the assimilation of the definite article /l/ to the following sun letters, *parsing* of sun and moon letters is quite symmetrical.

(34) Input**:** #fataħ-a# # l-ba:b-a#/ ‘he opened the door’

Table 8: OCP, IDENT-IO (PLACE), ONSET, *3μ, MAX-C-IO >> NOCODA, ALIGN (W)

#fataħ-a# #l-ba:b-a#	OCP	IDENT-IO (PLACE)	ONSET	*3μ	MAX-C-IO	NOCODA	ALIGN (W)
a. /fa.ta.ħal.ba:b.a/ l – [lateral] – Place – [coronal]; b – Place – [labial]			*!	*		***	*
b. /fa.ta.ħab.ba:.ba/		*!				****	*

							
c. ☞/fa.ta.ħal.ba:.ba/ 						****	*
d. /fa.ta.ħa.ba:.ba/ 					*!	*****	

Candidate (8a) presents the actual output. Yet, it is not the most harmonic, as it incurs fatal violations of ONSET and *3µ. The full assimilation of the definite article to the following non-coronal sound renders the second candidate suboptimal as it excessively violates IDENT-IO (PLACE), which stipulates the preservation of the input place features. Candidate (8c), on the other hand, wins the contest as it has free violations of the topmost set of constraints. The bottommost candidate is ruled out as it incurs a fatal violation of the high-ranking constraint MAX-C-IO.

In addition to the definite article, post-lexical resyllabification occurs when a preposition precedes the elidable glottal stop as in (35). It is rather evident from the example below that the elidable glottal stop deletes and a new syllable is formed after shortening the long vowel of the preposition [fi:] so as to avoid the surfacing of a trimoraic syllable.

(35)

#fi:# #?al-maktab-i# > /fil.mak.ta.bi/
'in the office'

Post-lexical resyllabification runs along similar lines in vocatives with regard not only to the drop of the prothesized syllable, but also to the shortening of the long vowel (Alqaasem 1993). Table (9) illustrates these exceptional cases.

(36) Input: /#ja:# # bn-a# #?axi#/
vocative son brother my
'oh my nephew'

Table 9: *3μ, MAX-C-IO, ONSET, *COMPLEX^{ONS} >> NO CODA, MAX-V-IO, ALIGN (W)

/#ja:# #bn-a# #?axi#/	*3μ	MAX-C-IO	ONSET	*COMPLEX^{ONS}	NO CODA	MAX-V-IO	ALIGN (W)
a. /ja:b.na.?a.xi/	*!				***		*
b. /ja:.bna.?a.xi/				*!	****		*
c. /jab.naa.xi/		*!			**	*	*
d. ☞/jab.na.?a.xi/					***	*	*

Being fully faithful to the input form is not sufficient to rescue candidate (9a) as it violates the high-ranked *3μ. By parsing two consonants as an onset of the second syllable, the second candidate could manage to avoid the penalty of *3μ, but at the expense of another fatal constraint *COMPLEX^{ONS} in addition to the numerous incurred violations of the low-ranking constraints ALIGN (W) and NOCODA. Candidate (9c), on the other hand, is discarded by MAX-C-IO, which prevents the deletion of input consonants. Despite the three incurred violations of the low-ranked constraints, the last candidate emerges as optimal since it has successfully satisfied all the top-ranked constraints.

The organization of segments within a syllable is usually governed by the SSP, where more sonorous segments come close to the syllable peak. However, languages clearly exhibit divergence with regard to the adherence to the SSP. A study conducted on coda clusters in SA shows that clusters that do not adhere to the SSP outweigh the ones that do (Al Tamimi & Al Shboul 2013). It should be reiterated that such clusters result from the deletion of the final short vowel or nunation (upon pausing). The following example shows that the deletion of the word-final short vowel or nunation results in a clear violation of the SSP, as shown in Table (10).

(37) SON

‘In a syllable, sonority increases toward the peak and decreases toward the margins.’

(Morelli 2003)

(38) Input: /ʕasˤr/# ‘age’

Table 10: ONSET, M-O-CONTIG>> DEP-IO, SON, NOCODA

/ʕasˤr/#	ONSET	M-O-CONTIG	DEP-IO	SON	NOCODA
a. /ʕa.sir/		*!	*		*
b. ☞ /ʕasˤr/				*	
c. /ʕasˤ.ir/	*!				

Splitting the underlying consonant clusters in coda position via the epenthetic high short vowel [i] has rendered candidate (10a) suboptimal as M-O-CONTIG strictly prohibits morpheme internal epenthesis. Although candidate (10b) violates SON, it is still selected as the optimal candidate owing to being the form with the least violations of the most harmful constraints. Therefore, input-output correspondence in SA is given precedence over the adherence to the SON constraint. The last candidate is eliminated by ONSET, which is undominated in all Arabic varieties.

4 Conclusion

This paper has shed light on some key issues on lexical and post-lexical resyllabification within the OT framework. By concentrating on descriptions, analyses, and fundamental phonological processes, the paper has attempted to explore the phonological and morphological factors that constrained the resyllabification process, in general. Evidence has shown that there are a lot of variations in the processes that SA employs to evade the surfacing of impermissible syllable structures and consonant clusters. Based on the evidence provided, it has become rather obvious that SA adopts several phonological processes such prosthesis, syncope and vowel shortening to avert the surface of impermissible clusters.

References

Abdo, Daud. 1969. *On Stress and Arabic Phonology: A Generative Approach*. Beirut: Khayats.

Abu-Abbas, Khaled. 2003. *Topics in the phonology of Jordanian Arabic: An optimality theory perspective*. Kansas: University of Kansas. (Doctoral dissertation.)

Abu Mansour, Mahasen Hasan. 1995. Optimality and conspiracy in the syllable structure of Arabic. In Beckman, Jill & Dickey, Laura Walsh & Urbanczyk, Suzanne (ed.), *University of Massachusetts Occasional Papers: Papers in Optimality Theory* 18. 1–20.

Abu-Salim, Isam. 1982. *A reanalysis of some aspects of Arabic phonology: A metrical approach*. Urbana: University of Illinois at Urbana-Champaign. (Doctoral dissertation.)

Adra, Mohammad. 1999. *Identity effects and opacity in Syrian Arabic: An optimality theory analysis*. Urbana: University of Illinois at Urbana-Champaign. (Doctoral dissertation.)

Al-Ani, Salman. 1970. *Arabic Phonology: An Acoustical and Physiological Investigation*. The Hague: Mouton.

Algasem, Yahya. 1993. Athar almaqta' almarfood fi buniat alkalimati al'arabiyah [Translated: The Impact of the Rejected Syllable in the Structure of Arabic Word], *Abhaath Al-Yarmouk* 11(2). 149 –178.

Alghazo, Mohammad. 1987. *Syncope and epenthesis in Levantine Arabic: A nonlinear approach*. Urbana: University of Illinois at Urbana-Champaign. (Doctoral dissertation.)

Al Mashaqba, Bassil. 2015. *The phonology and morphology of Wādi Ramm Arabic*. Salford University, UK.

Al Tamimi, Yaser & Al Shboul, Yousef. 2013. Is the phonotactics of the Arabic complex coda sonority-based?, *Journal of King Saud University – Language and Translation* 25(1). 21–33.

Bolinger, Dwight. 1975. *Aspects of Language*, (2nd edition). New York: Harcourt Brace Jovanovich.

Brame, Michael. 1970. *Arabic phonology: Implications for phonological theory and historical Semitic*. Cambridge: Massachusetts Institute of Technology. (Doctoral dissertation.)

Btoosh, Mousa A. 2006. Constraint interactions in Jordanian Arabic phonotactics: An optimality theoretic approach. *Journal of Language and Linguistics* 5(2). 192– 221.

Btoosh, Mousa A. 2018. Rules or constraints? A cross methodological comparison of approaches to 'syncope' and 'vowel shortening' in Cairene Arabic. *SKASE Journal of Theoretical Linguistics* 15(1). 59–79.

Chomsky, Noam & Halle, Morris. 1968. *The Sound Pattern of English*. New York: Harper and Row.

Comrie, Bernard. 2006. Transitivity pairs, markedness, and diachronic stability. *Linguistics* 44(2). 303–318.

Davis, Stuart. 2002. Syllable Structure for an Artificial Language Based on Universal Principles. *Journal of Universal Language* 3. 3–15.

Dickins, James. 2007. *Sudanese Arabic: Phonematics and Syllable Structure*. Wiesbaden: Harrassowitz.

Erdmann, Benno & Dodge, Raymond. 1898. *Psychologische Untersuchungen fiber das Lesen auf experimenteller Grundlage*. Halle: Niemeyer.

Fudge, Eric. 1965. The nature of phonological primes. *Journal of Linguistics* 3. 1–36.

Gadoua, Abdulhamid. 2000. '*Consonant clusters in Quranic Arabic'*. *Cahiers Linguistiques d'Ottawa* 28. 59–85.

Goldsmith, John. 2011. The syllable. In John A. Goldsmith, Jason Riggle & Yu, Alan C. L. (eds.). *The Handbook of Phonological Theory*, (2nd edition), 164–196. Chichester and Malden: Wiley-Blackwell.

Goslin, Jeremy & Frauenfelder, Uli. 2001. A comparison of theoretical and human syllabification. *Language and Speech* 44(4). 409–436.

Harris, John & Gussman, Edmund. 2003. Word-Final Onsets. ROA- 575-0203. http://roa.rutgers.edu/view.php3?roa=575 (Retrieved on May 12, 2018).

Haugen, Einar. 1956. The syllable in linguistic description. In: Halle, Morris, Lunt, H. G. & McLean. H. (eds.), For Roman Jacobson, 213–221. Den Haag: Mouton.

Heselwood, Barry & Watson, Janet C. E. 2013. The Arabic definite article does not assimilate. *Leeds Working Papers in Linguistics and Phonetics* 18. 34–53.

Hwaidi, Tamader. 2016. *Syllable structure and syllabification in Al'ain Libyan Arabic*. Newcastle: Newcastle University. (Doctoral dissertation.)

Kager, René. 2004. *Optimality Theory*. Cambridge: Cambridge University Press.

Kenstowicz, Michael. 1994. *Phonology in Generative Grammar*. Cambridge (Mass.) Oxford: Blackwell.

Kiparsky, P. 2003. Syllables and Moras in Arabic. In Caroline Fery & Ruben Van De Vijver (Eds.), *The Syllable in Optimality Theory*, 147–183. Cambridge: Cambridge University Press.

Landman, Meredith. 2003. Morphological contiguity. In Carpenter, Andrea, Coetzee, Andries & de Lacy, Paul (eds.), *University of Massachusetts Amherst Occasional Papers in Linguistics 26: Papers in Optimality Theory II*. Amherst: Graduate Student Linguistic Association Publications.

Liberman, Isabelle & Shankweiler, Donald & Fischer, F. William & Carter, Bonnie. 1974. Explicit syllable and phoneme segmentation in the young child. *Journal of Experimental Child Psychology* 18. 201–212.

McCarthy, John. 1979. *Formal Problems in Semitic Phonology and Morphology*. Cambridge, Mass. (Doctoral dissertation.)

McCarthy, John. 1986. OCP effects: Gemination and antigemination, *Linguistic Inquiry* 17. 207–63.

McCarthy, John. 2010. Autosegmental spreading in Optimality Theory. In John Goldsmith, Elizabeth Hume, & Leo Wetzels, (eds.), *Tones and Features*, 195–222. Berlin and New York: Mouton de Gruyter.

McCarthy, John J. & Alan Prince. 1993. *Prosodic Morphology I: Constraint Interaction and Satisfaction*. Ms., University of Massachusetts, Amherst and Rutgers University, New Brunswick.

McCarthy, John & Alan Prince. 1995. Faithfulness and reduplicative identity. *University of Massachusetts Occasional Papers* 18. 249–384.

McCarthy, John & Joe Parter (eds.). 2016. *Harmonic Grammar and Harmonic Serialism*. London: Equinox.

Mehler, J., Dommergues, J., Frauenfelder, U., & Segui, J. 1981. The syllables role in speech segmentation. *Journal of Verbal Learning and Verbal Behavior* 20. 298–305.

Mobaidin, Hosam Eddin. 1999. Consonant underpaying in Arabic: An optimality theoretic approach. Dirasat, *Proceedings of F.I.C.A.E.C.C.S Special Issue*, University of Jordan.

Morelli, Frida (2003), The Relative Harmony of /s stop/Onsets: Obstruent Clusters and the Sonority Sequencing Principle. In Féry, Carolin & van de Vijver, Ruben (eds.), *The Syllable in Optimality Theory*, 356–371. Cambridge: Cambridge University Press.

Prince, Alan & Paul Smolensky. 1993. *Optimality Theory: Constraint Interaction in Generative Grammar*. Blackwell, Malden, MA and Oxford, UK.

Rakhieh, Bilal. 2009. *The phonology of Ma'ani Arabic: Stratal or parallel OT*. Essex: University of Essex. (Doctoral dissertation.)

Ryding, Karin. 2005. *A Reference Grammar of Modern Standard Arabic*. Cambridge: Cambridge University Press.

Steriade, Donca. 1999. Alternatives to syllable-based accounts of consonantal phonotactics. In Osamu Fujimura, Brian Joseph & Palek, Bohumil (eds.), *Proceedings of the 1998 Linguistics and Phonetics Conference*, 205–242. Prague: Karolinum Press.

Watson, Janet. 2002. *The Phonology and Morphology of Arabic*. Oxford: Oxford University Press.

Yip, Moira. 1994. *Phonological constraints, optimality, and phonetic realization in Cantonese*. Colloquium, University of Pennsylvania.

Yip, Moira. 2002. *Tone*. Cambridge: Cambridge University Press.

Youssef, Islam. 2013. *Place assimilation in Arabic: contrasts, features, and constraints*. Tromsø: University of Tromsø. (Doctoral dissertation.)

Zughoul, Muhammad. 1980. Diglossia in Arabic: Investigating solutions. *Anthropological Linguistics* 22(5). 201–217.

Mousa A. Btoosh, Ph.D.,
Dept. of English Language and Translation
Fahad Bin Sultan University
P.O. Box 15700
Tabuk 71454, SA
e-mail: mbtoosh@fbsu.edu.sa
mousa.btoosh@gmail.com

Appendix

Romanized symbols for Arabic consonants and vowels and their corresponding IPA symbols

Romanized Symbols Used for Arabic Consonants and Vowels	International Phonetic Alphabet
?	[ʔ] glottal plosive
b	[b] voiced bilabial plosive
t	[t] voiceless alveolar plosive
th	[θ] voiceless inter-dental fricative
j	[dʒ] voiced post-alveolar affricate
h	[ħ] voiceless pharyngeal fricative
kh	[x] voiceless velar fricative
d	[d] voiced alveolar plosive
th	[ð] voiced inter-dental fricative
r	[ɾ] alveolar tap
z	[z] voiced alveolar fricative
s	[s] voiceless alveolar fricative
sh	[ʃ] voiceless post-alveolar fricative
s	[sˤ] emphatic voiceless alveolar fricative
d	[d̪ˤ] emphatic voiced alveolar plosive
t	[t̪ˤ]voiceless dental plosive
TH	[ðˤ] emphatic voiced alveolar fricative
c	[ʕ] voiced pharyngeal fricative
gh	[ɣ] voiced velar fricative
f	[f] voiceless labiodental fricative
q	[q] voiced uvular plosive
k	[k] voiceless velar plosive
l	[l] alveolar lateral
m	[m] bilabial nasal
n	[n] alveolar nasal
h	[h] voiceless glottal fricative
w	[w] voiced labialized approximant
y	[j] palatal approximant
[a]	[a] low, front, lax, unrounded
[a:]	[a:] low, front, tense, unrounded

[u]	[u] high, back, lax, rounded
[u:]	[u:] high, back, tense, rounded
[i]	[i] high, front, lax, unrounded
[i:]	[i:] high, front, tense, unrounded
[aw]	[aw] diphthong
[ay]	[ay] diphthong