Word-Final Consonant Clusters In Three Dialects Of Arabic

Ahmad Ismail Asiri

College of Languages and Translation
King Khalid University
Abha, Saudi Arabia
ahasiri@kku.edu.sa

Abstract:

This paper describes how word-final consonant clusters are treated in three different dialects of Arabic, Lebanese Arabic (LA), Jordanian Arabic (JA), and Asiri Arabic (AA) (spoken in southwestern Saudi Arabia). In each dialect, consonant clusters in word-final CVCC syllables are treated differently: An epenthetic vowel is inserted between these two consonants across the board in JA; an epenthetic vowel is always prohibited in AA; and, an epenthetic vowel breaks up only some of the word-final clusters in LA. It further seeks to analyze the different patterns of vowel epenthesis in CVCC consonant clusters in each of these dialects. To explain the LA data, basic premises of Government Phonology will be adopted; to explain the differences between these dialects, a broader explanation of the data will also be demonstrated within the Optimality theory model.

ملخص:

يتطرق البحث إلى حالة الحرفين الساكنين المتتاليين في نهاية المقطع اللفظي (CVCC) وذلك في ثلاث من اللهجات العربية: اللبنانية، الأردنية، واللهجة العسيرية. تختلف حالة استخدام الحرفين الساكنين المتتاليين في المقطع اللفظي (CVCC) من لهجة إلى أخرى. ففي اللهجة الأردنية، يتم إضافة حرف متحرك ليفصل بين هذين الحرفين الساكنين، بينما لا يمكن إضافة حرف متحرك بين هذين الحرفين في اللهجة العسيرية. أما في اللهجة اللبنانية، فيتم إضافة حرف متحرك بين هذين الحرفين الساكنين (كما في اللهجة الأردنية) وذلك في بعض الحالات، بينما يمنع إضافة أي حرف متحرك في حالات أخرى (كما في اللهجة العسيرية). ولتفسير ما يحدث من إضافة لحرف متحرك – أو عدم إضافته- بين الحرفين الساكنين المتتاليين في المقطع اللفظي (CVCC) في كل من اللهجات الثلاث، استخدم البحث الحالي الفرضيات الأساسية في كل من نظريتي الأصوات الكلامية العاملية "Government Phonology" والنظرية الانتقائية "Optimality Theory".

I- Introduction

In modern times, as presumably was the case in old times, Arabic speakers seldom use Classical Arabic in informal situations, as they use regional vernaculars, such as Moroccan Arabic, Egyptian Arabic, Iraqi Arabic, etc. Classical Arabic is now restricted to infomedia and academia. Categorically, the main dialects of vernacular Arabic can be classified into North African dialects, dialects of the Levant, and the Gulf region dialects or Arabian Arabic. Within this taxonomy of dialects, there are distinct dialectal variations (Van Mol, 2003). Even within one country, people have their own dialects where people demonstrate sharply distinct lexical, structural, syntactic, phonetic and phonological variations. In Saudi Arabia, for instance, people differ in their speech across the major five regions of the semi-continental state.

The universal structure of Arabic is characteristically CV - an unmarked syllable structure (Carlisle, 2001; Lowenstamm, 1996). Crudely put, this structure describes the ideal syllable structure: one that has one peak only and yet allows no more than a single vowel (Angoujard, 1990; Cairns & Feinstein, 1982).

Ideally, all languages, tone or stress, allow for a CV syllable structure, and a few may allow more complex syllabic structures. However, if a language allows only a CV syllable structure, then it is customary that the speakers of that language simplify a CVC input. In that case, no modification is needed if a language allows CVC. For those languages that fail to allow a CVC, speakers often tend to remove the coda to simplify the syllable to a CV structure as in French *fin* ‘end’ which is simplified to /ƒa/ or the Italian *fac* ‘make’ which becomes /ƒa/ (Vennemann, 1987). This process of simplification occurs not only in clusters, but also in codas and onsets (Vennemann, 1987). Consequently, complex codas, e.g., CVCC, may be modified and reduced to CVC. This occurs not only in languages but also in dialects within a language. Therefore, the longer the codas and onsets in a given language, the more user-modified these become (Carlisle, 1998). Hyman (2008) aptly observed that in cases where a language has frequent repetitions of CV, complex sequences of sounds, both consonants and vowels, are always seen to be more challenging for language speakers in terms of enunciation. One solution could be adding epenthesis in cases of having more than one consonant in onsets or codas, as is the case of some Arabian dialects.

Upon that, the researcher seeks to describe final consonant clusters (i.e., CVCC) in the lexicons of three different dialects of modern Arabic, namely Lebanese Arabic (LA), Jordanian Arabic (JA), and Asiri Arabic (AA). Consonant clusters in CVCC syllables across these dialects make use of adding or dropping an epenthetic vowel. The researcher, subsequently, analyzes the varied patterns of vowel epenthesis or no epenthesis in each of these dialects contrastively as will be discussed in the sections to follow.

II- Overview of the data

The data comes from three different dialects of Arabic: JA, AA, and LA. In each dialect, consonant clusters in CVCC syllables are treated differently in that an epenthetic vowel may or may not be inserted between the two final consonants, as shown in table(1):

(1) CVCC examples from LA, JA, and AA

	UR(1)	LA	JA	AA	Gloss
a	/ʕawj/	[ʕawi]	[ʕawi]	[ʕawi]	Barking
b	/dalw/	[dalu]	[dalu]	[dalu]	Pail
c	/xajl/	[xajl]	[xeel]	[xeel]	Horses
d	/ɣajr/	[ɣajr]	[ɣeer]	[ɣeer]	Other than
e	/ħarf/	[ħarf]	[ħaruf]	[ħarf]	Letter
f	/fils/	[fils]	[filis]	[fils]	Small coin
g	/ħafr/	[ħafir]	[ħafur]	[ħafr]	Digging

Table (1) shows examples of how consonant clusters are treated in these dialects. It also shows that when a sequence of glide-glide and consonant-glide clusters occur, a process of Glide Vocalization (GV) applies to the second consonant changing it to a corresponding vowel (e.g., a and b).

When the reversed order occurs as in glide-consonant cluster, a phonological process of Coalescence (C) applies in both JA and AA, causing the vowel and the glide to become one long vowel (e.g., c and d). LA, however, differs from these two dialects in that no change occurs to either the glide or the consonant that follows (e.g., [ɣajr]).

Table (1) also shows variation

(1) It is assumed here that the Underlying Represen-tation (UR) is the same for all three dialects.

among the three dialects with regard to other consonant clusters (non-glide consonants): In LA, for instance, an epenthetic vowel (i.e., [i]) is inserted between the two consonants in (g) but not in (e) or (f).

In JA, an epenthetic vowel is inserted between any two consonants in a cluster across the board in (e.g., e-g). To the contrary, AA does not allow epenthesis to apply between conson-ants in the same set of clusters.

All in all, AA and JA exhibit two extreme views with regard to word-final consonant clusters in CVCC syllables: absolute epenthesis in JA versus no epenthesis in AA (the AA and JA data will be discussed further in section V.A).

Between these two extreme treatments of word-final clusters, LA differs in that it exhibits cases of both epenthesis and no epenthesis of a vowel between consonant clusters in CVCC syllables. As will be shown, the LA data indicates that these states of epenthesis and lack of epenthesis depend on the segmental representation (sonority and place structures) of each consonant in word-final clusters. To account for variation between epenthesis and lack of epenthesis in word-final consonant clusters in these dialects, some of the basic premises of Government Phonology (GP) will be adopted. Nevertheless, before presenting the GP framework, we shall consider how the syllable structure of CVCC in Arabic has been analyzed in the literature.

III- Background assumptions

A. CVCC syllable structure in Arabic

LA, JA, and AA share the syllable patterns of CV, CVV, CVC, CVVC, and CVCC (see, e.g., Abu-Salim & Abd-el-Jawad, 1988 for LA and JA). The focus of this paper, however, will be on one of these patterns: the CVCC syllable type. The CVCC syllable is the maximal syllabification domain in all three dialects. In most varieties of Arabic, the CVCC syllable is often found in both domain-internal (e.g., 2a) and domain-final positions (e.g., 2b) (throughout this paper, the consonants in the CVCC syllable will be numbered as C1, C2, and C3 for clarity). Clusters in domain-final position (e.g., 2b) will be analyzed in this paper.

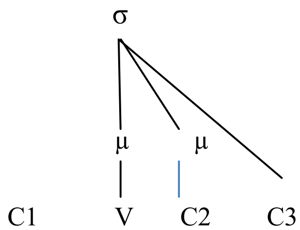
(2) Domains of CVCC

a. ʔa**kalt**ha ‘I ate it (f.)’

b. **kalb** ‘dog’

The final consonant in the CVCC syll-able (i.e., C3 in example (3)) has received different analyses in the literature: Some researchers have argued that it is a non-moraic addition to the coda (Mahfoudhi, 2005; Kiparsky, 2003):

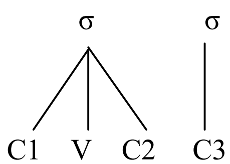
(3) Final consonant in CVCC: non-moraic analysis



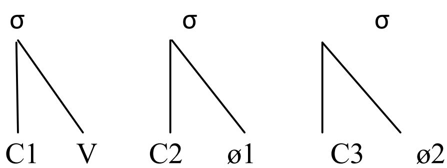
This final consonant (C3) has also been analyzed as an extrasyllabic entity (e.g., Watson, 2002). For example, it has been analyzed as an onset heading a degenerate syllable0, in both Makkan and Cairene Arabic, respectively (e.g., Abu-Mansour, 1991; Selkirk, 1981). Both analyses have in common the assumption that C3 is non-moraic. It will be assumed here that the CVCC syllable should have the following structure:

(4) CVCC syllable analysis

(a) Surface



(b) Underlying



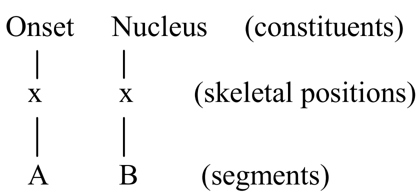
As in GP (see below for references), it will also be assumed that abstract nuclei exist after C2 and C3. In other words, the existence of a surface form (i.e., CVCC) and an underlying form of the same syllable (i.e., CVCøCø), yet with an empty nucleus following each consonant in the cluster, will be assumed.

The following subsections discuss the licensing relationships between consonants in word-final consonant clusters (i.e., C2 and C3) in the CVCC syllable. To explain such relationships, some general principles and premises of GP must be introduced first.

B- Government Phonology (GP)

This subsection introduces some general premises of GP, as proposed by Kaye, Lowenstamm & Vergnaud (1990) (henceforth KLV). In this framework, segments have governing properties which, in turn, decide where a segment may or may not occur in a syllable. In GP, segments are projected into intermediary skeletal points or *slots* which are projected further into constituents. (Skeletal positions will be omitted from later examples).

(5) Constituents in GP



There are three constituents in GP: the Onset (O), the Nucleus (N), and the Rhyme (R); each of which can be either branching or non-branching. Moreover, two segments can be in a binary relation based on the governing properties of each segment.

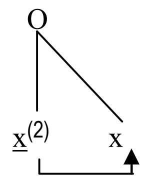
A syllabic constituent is a governing domain and in this syllabic constituent, the government relation between two segments has to be both strictly local (i.e., the governor must be adjacent to the governee) and strictly directional; thus, "for two segments to cooccur within a constituent, their permitted position is determined by their governing properties" (KLV, p. 200). Accordingly, two types of government relationship in constituents have been proposed:

(6) Types of government

a. Within-constituent;
b. Between-constituent.

A within-constituent governing relationship in onsets (e.g., (7)) is established when a less sonorous[1] segment(i.e., an obstruent) is associated to the head position and a more sonorous segment (i.e., a liquid or glide) appears to its right (KLV, p. 203); that is, onsets are defined as head-initial governing domains:

(7) Within-constituent government (onsets)



In this branching onset, the head (underlined) is the leftmost position.

For between-constituent government to occur, certain principles must be met:

(8) Conditions on between-constituent government (KLV, p. 210)

a. Only the head of a constituent may govern.

b. Only the nucleus may govern a constituent head.

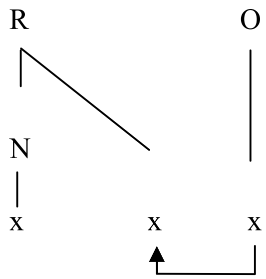
Between-constituent government is head-final (KLV, p. 213). (However, the direction of government between full and empty nuclei is a different matter, as will be discussed shortly.) The following are possible between-constituent governing positions:

(1) In GP, segments with little sonority are negatively charmed; segments with greater sonority (e.g., vowels) are positively charmed.

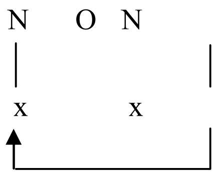
(2) In GP, the direction of lines is important in that a straight (vertical) line indicates a head; whereas an inclined line indicates a dependent of that head ('x' here stands for 'any segment').

(9) Between-constituent governing positions

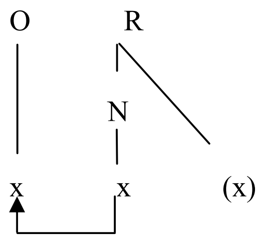
a. Government between an onset and a preceding rhymal position (coda):



b. Government between contiguous nuclei:



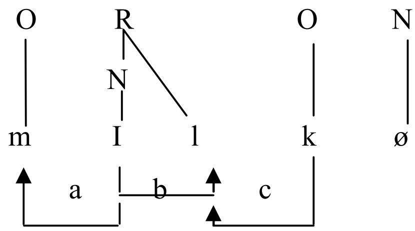
c. Government between a rhymal position and an onset:



The between-constituent type of government will be the most relevant to this paper. It becomes central to the discussion when government relations between segments in the CVCC word-final consonant clusters are considered. However, (a) in (9) describes the type of government relationship for surface CVCC syllables (Cf. 4a). (Note that a modified version for the underlying structure in (4b) will be adopted).

For an illustration of government, consider how government relations function in the word *milk*. (The final empty nucleus in (10) will be discussed in short order.) Note that only the surface structure (i.e., 4a) of this syllable is shown.

(10) Various governing relations in 'milk' (surface structure)



In this example, a between-constituent government holds between the nucleus /i/ and the onset /m/ (i.e., (10)). In (10), a within-constituent government occurs where the nucleus /i/ and its complement /l/. Another type of between-constituent government also holds between onset /k/ and coda /l/ in (10).

The governing relation in (10) is an instance of Kaye's (1990) Coda Licensing Principle (CLP):

(11) Coda Licensing Principle: Post-nuclear rhymal positions [i.e., "codas"] must be licensed by a following onset.

The CLP is relevant because complex codas *per se* do not exist in GP; instead, word-final consonant clusters are considered as coda + onset positions (see (4)), with a between-constituent government relationship (the CLP). (See (13) below for a different argument of coda + onset positions).

The CLP itself can be seen as a variant of the Syllable Contact Law (Murray & Vennemann, 1983, in Clements, 1990):

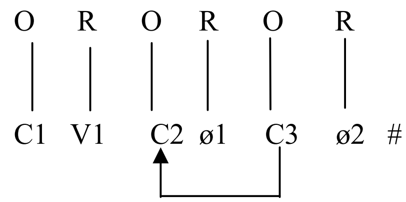
(12) Syllable Contact Law (SCL)

The preference for a syllabic structure A$B, where A and B are segments and *a* and *b* are the sonority values of A and B respectively, increases with the value of *a* minus *b*.

The SCL states that in a consonant cluster, the first consonant (i.e., the coda) must have equal or more sonorous than a following consonant (i.e., the onset). Both the SCL and the CLP are almost identical in the sense that both state that a consonant in onset position affects what type of consonant can occur in the preceding coda position. That is, in a word-final consonant cluster (as in CVCC), the last consonant must govern the second-last one. This basic idea of coda-onset government will be adopted in the paper.

However, coda-onset government must be reformulated, for a stricter version of GP is assumed, where there are no codas *per se*, but rather, only onsets. (Ultimately, this assumption helps to characterize the conditions under which rhyme ø1 is realized in example (13) below. Therefore, it is assumed that, both of the word-final consonants (C2 and C3) in Arabic CVCC syllable are abstract onsets, as shown in 0). This assumption however requires a modification of the CLP / SCL, which is described below.

(13) CLP/ SCL, reanalyzed as onset-to-onset government



Example (13) assumes that all consonants are onsets at an abstract (underlying) level (i.e., CVCøCø), as in (4b). Given this assumption, the relation between word-final consonants (C2 and C3) is onset-to-onset government (replacing CLP/SCL relationships), where C3 (onset) governs C2 (onset); the direction of government goes from right to left.

As shown in (13), the existence of

abstract empty nuclei in a CVCC syllable is assumed. Empty nuclei receive no phonetic interpretation (i.e., they remain silent) if certain conditions on where they must occur are met. Their existence is not random, but rather, is strictly determined by the Empty Category Principle (ECP) in (14):

(14) Empty Category Principle: A position may be uninterpreted phonetically (not pronounced) if it is properly governed. (KLV, p. 219)

The following two examples illustrate both the CLP in (11) and the ECP in (14). Example (15) illustrates the representation of a word-final consonant cluster.

(15) Treatment of word-final consonant clusters (UR for CVCC)

```
O    R    O    R    O    R
|    |    |    |    |    |
|    N    |    |    |    |
|    |    |    |    |    |
x    x    x    x    x    x
|    |    |    |    |    |
m    i    l    ø    k    ø
```

Underlyingly, the segment /l/ in the English word *milk* is followed by an empty nucleus (ø), which separates /l/ from the following onset /k/. Accor-ding to the CLP, /k/ should govern /l/. Note that the final constituent in (15) contains another empty nucleus (ø), which will be discussed in some detail below. Example (16), on the other hand, illustrates the representation of a single word-final consonant. Consider how the ECP functions in the word *man*:

(16) ECP

```
O    N    O    N
|    |    |    |
x    x    x    x
|    |    |    |
m    æ    n    ø
```

The closed syllable [mæn] in (16) is abstractly represented as two open syllables. The final syllable consists of an onset followed by an empty nucleus (ø) which governs it, as in (9c). The ECP stipulates that for this empty nucleus to remain inaudible, it has to be properly governed:

(17) Proper government

a. The governor may not itself be governed,

b. The domain of proper government may not include a governing domain.

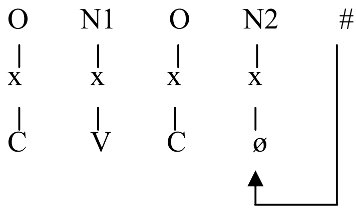
Proper government asserts that because the nucleus [æ] in (16) is audible; it must not be governed. In contrast, the final empty nucleus is governed by the mechanisms discussed next.

Thus far, it has been shown that an empty nucleus remains inaudible if it is properly governed and audible otherwise. The question, then, is how would the final empty nuclei in (15) and (16) be governed in order for them to remain inaudible? Two mechanisms are considered next.

The first licensing mechanism entails

that "domain-final position is a potentially licensed position" (Kaye, 1990, p. 314). Thus, the empty nuclei in (15) and (16) can be prosodically-licensed (P-licensed), as in (18):

(18) Prosodic licensing

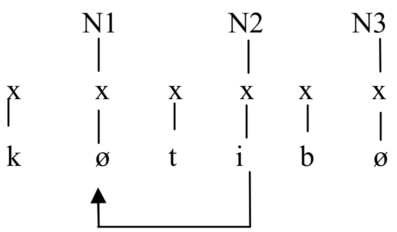


(# is domain-final position)

Kaye argues that Arabic is such a language where an empty nucleus at the edge of the word is P-licensed.

A second licensing mechanism for word-initial consonant clusters is also proposed by Kaye. In this method, an audible vowel governs/licenses a contiguous empty nucleus. For example, a word such as *ktib* 'I write' in Moroccan Arabic (MA) would have the following representation:

(19) Empty Nucleus in MA

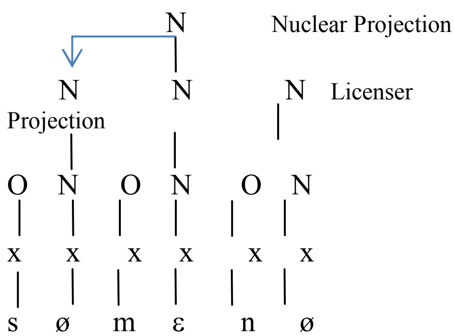


- N2 not properly governed (thus audible)
- N3 P-licensed (thus inaudible)

According to Kaye, the initial [k] in the [kt] cluster is an onset which is followed by an empty nucleus (N1), which is not phonetically realized because it is properly governed by a contiguous nucleus (i.e., N2). This relationship is a between-constituent type of government (cf. (9)).

Right-to-left government between a full nucleus and a preceding empty one is also observed in French (Charette, 1990[1]):

(20) Nuclei government in French

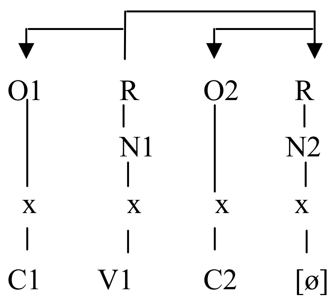


semaine [smɛn] 'week'

(1) According to Kaye, government applies at the level of nuclear projection. Charette (1990), however, proposes that government does not apply at the level of nuclear projection; instead, it operates at *licenser projection* level. The empty nucleus is adjacent to a proper governor at the level of licenser projection. The properly governed empty nucleus (as well as the licensed word-final one) is not present on the level of nuclear projection (p. 239). Only the unlicensed positions are projected on the Nuclear Projection.

In 0Error! Reference source not found.(20), government between the full nucleus [ɛ] and the empty nucleus [ø] proceeds from right to left. However, the direction of government between full and empty nuclei is not always from right to left. For example, in Beijing Mandarin, government goes from left to right (Yoshida, 2003):

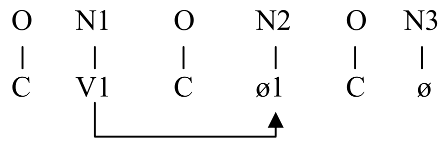
(21) Nuclei government in Beijing Mandarin[1]



What all the above examples have in common is that a full vowel within a word governs an empty vowel at the word's edge. Later in the discussion, it will be assumed that in a CVCC syllable, a full vowel (e.g., V1) in (22) can govern a contiguous empty nucleus (i.e., ø1). It will also be argued that if this type of government fails to apply, then the empty nucleus (ø1) will be realized as a full vowel:

(1) In Yoshida's original example, no actual segments were provided; and, for clarification, empty nucleus [ø] has been added to example (21).

(22) Nucleus government in CVCC (initial analysis)



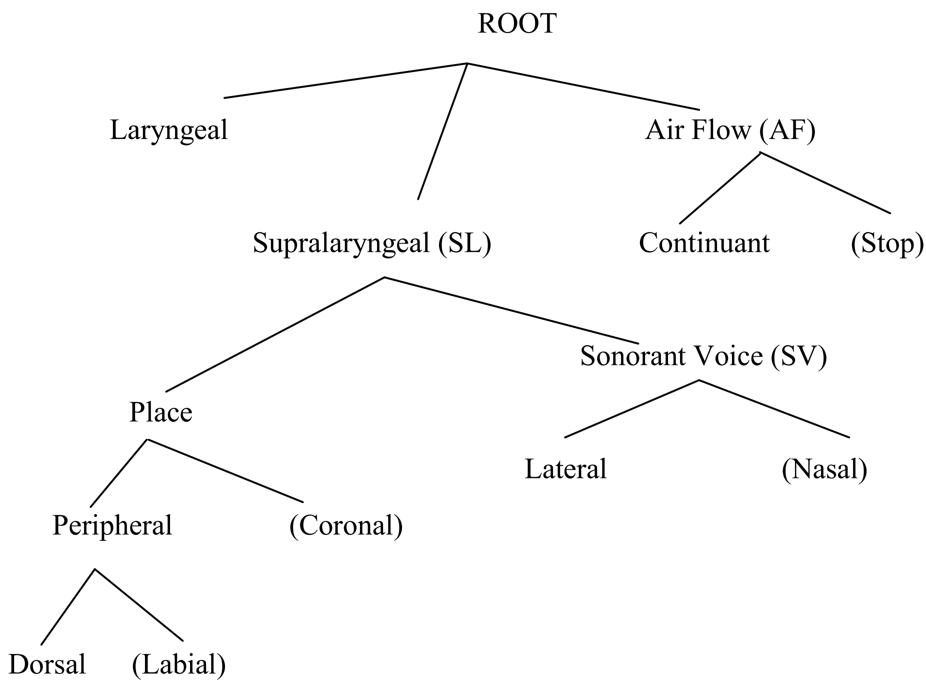
In the next subsection, Rice's (1992) work on consonantal government will be introduced. Rice's framework has elements in common with GP; however, Rice formalizes both sonority-based and place-structure-based aspects of government and associates these aspects with segments' structures. The structural-based aspects of Rice's account will be adopted for the purpose of analyzing word-final consonant clusters in Arabic (as opposed to KLV's (1990) notion of charm).

C. Rice's (1992) assumptions

This subsection highlights Rice's explanation of governing relationships between consonants in clusters. As in GP, Rice argues that the internal structure of a consonant determines its position in a syllable. To provide evidence for this assumption, she develops constraints on the syllabification of consonant clusters by examining sonority as well as the place of articulation of segments in a cluster. In this paper, Rice's basic assumptions on segment structure will be adopted in addition to Clements & Hume's (1995) feature geometry. However, it will be shown that the basic tenets of feature geometry are explained below using Rice's geometry. The collaboration of these different frameworks will help explain the variation noticed between epenthesis and lack of epenthesis in CVCC consonant clusters, as will be shown shortly. Particularly, without some modifications, Rice's work alone will not provide straightforward explanations for the Arabic data; therefore, assistance from other frameworks such as Clements& Hume's feature geometry becomes necessary for the purpose of this paper.

Rice argues that constraints on sonority and place of articulation are *structurally* defined and proposes the following representation of segments' *structures* (the direction of lines is not significant in feature geometry):

(23) Rice's Consonantal Structure



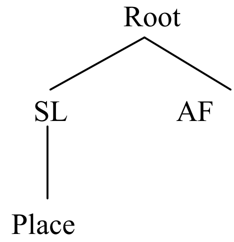
The major constituents of Laryngeal, Supralaryngeal, Air Flow, Place, and Sonorant Voice (SV) are organizing nodes which provide information about such constituents or "define sets of features that function together as units with respect to phonological processes such as assimilation, OCP (Obligatory Contour Principle)effects and delinking" (Rice, 1992, p. 62). For example, rules of place of articulation assimilation apply to features dominated by the Place node; in contrast, rules of sonorant assimilation occur in the SV node (SV takes the place of the feature [Sonorant] found in other systems (see, Rice, 1993)). Other nodes (e.g., Labial, Dorsal, Lateral, etc.) are called content nodes.

The organizing nodes are in a dependency relationship. In other words, if a phonological rule is to apply to dependents of a lower node in one constituency, the higher constituency dominating this node will not be affected by this rule. In contrast, if a phonological rule applies to a higher constituency node, lower nodes dominated by this (higher) constituent must also be affected.

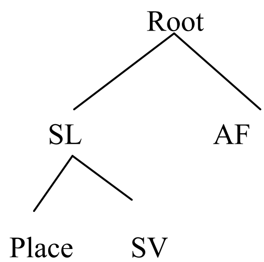
Rice further assumes that segments are not fully specified; that is, unmarked content features (in parentheses in (23)) are absent from underlying representation (UR). Therefore, by default, under the Place node, for instance, the Coronal feature is absent from the UR (24 a); and the Nasal feature is absent under the SV node(24 b):

(24) Various representations of Coronals

a. Coronal stop



b. Coronal nasal



According to Rice, one advantage of this model is that it highlights markedness relations, where marked segments have more structure than unmarked segments. That is, because coronals are universally unmarked, they must have less structure. (This assumption of the unmarkedness of coronals will be adopted in the discussion of coronal structure in0.

Based on Clements' (1990) sonority scale in (25), Rice discusses sonority relationships that exist between consonants, and proposes that it is possible to represent sonority structurally.

(25) Sonority Scale

Least sonorous obstruent < nasal < liquid < glide < vowel Most sonorous

Putting together the segmental representation in (23) and the sonority scale in (25), Rice introduces the notion of government. Rice's basic assumptions about segment structure will be adopted in this paper.

In the next subsections, the concepts of government and binding in Rice's work will be introduced. In subsection D, however, some modifications to these concepts will be implemented in order to provide a unified explanation for epenthesis and lack of epenthesis in Arabic CVCC syllables.

1. Government:

Rice argues that a less sonorous segment such as an obstruent would have less SV-structure, while a more sonorous segment such as a liquid would have more SV-structure. She argues then that liquids, nasals, and obstruents can have the following SV-structures:

(26) Segments' SV-structures (Rice, 1992, p. 65)

Liquid	Nasal	Obstruent
ROOT	ROOT	ROOT
|	|	
SV	SV	
|		
Lateral		

The SV structure of the segments in (26) (26) increases from right to left with obstruents having the least SV structure and liquids the most.

Like sonority, Rice argues that segments' place structures are important for structural relationships between segments; she introduces the notion of *binding* in order to account for non-sonority-based relationships between consonants in clusters. In the following paragraphs, we will see how binding explains facts such as the prohibition English places against onsets such as *tl and *dl. The notion of binding will be adopted as it is central to the current discussion of the Arabic data. Like government, binding will be later modified in order to provide an account of the Arabic data.

2. Binding:

Based on the segmental representation in (23), Rice assumes the following place structures of labial, coronal, and dorsal segments (in Rice's original example, the place structure of glottal stop was included; see example (40) (40) for laryngeals).

(27) Segments' place-structures (Rice, 1992, p. 75)

Labial	Coronal	Dorsal
ROOT	ROOT	ROOT
Place	Place	Place
Labial		Dorsal

From these representations, a coronal segment has less place structure than either dorsal or labial segments. While both dorsal and labial segments have the same amount of place structure, they are not identical.

After characterizing segments' SV- and place-structures, Rice introduces the notions of *government* and *binding* relationships that exist between consonants in clusters:

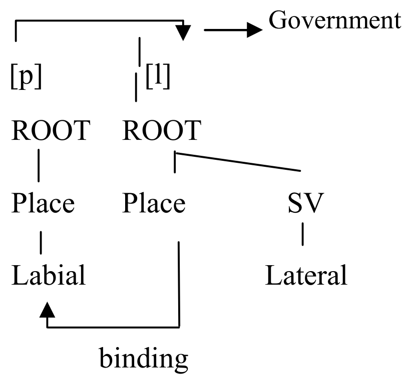
(28) Government and binding relationships:

a. A governs B if B has more relevant [*sonorant*] structure than A.

b. A binds B if A has equal or less relevant [*place*] structure than B.

Consider, for example, how government and binding would function in the word-initial cluster [pl] in English:

(29) Illustration of government and binding



- [p] has less SV structure than [l]; therefore, it is governed by [p].
- [p] has more place structure than [l]; therefore, [l] binds [p] (since it has less place structure).

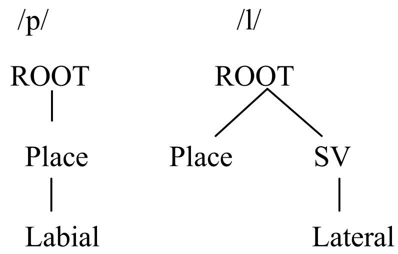
In other words, sonority dictates the type of government relationship between two adjacent consonants; in contrast, the amount of place structure shapes the binding relationship between the same consonants.

Based on the type of government and/or binding relationships that exist between two consonants in a cluster, Rice proposes that it is possible to account for the sequencing of consonant clusters in both hetero-syllabic (between-constituent) and taut-osyllabic (within-constituent) structures.

As has been shown, GP states that for two adjacent consonants to be syllabified in a branching onset (tautosyllabically), the first consonant has to have less SV structure than the second. Thus, in English, for instance, tautosyllabic onset clusters such as /gl/, /bl/, /dr/, and /kr/ are allowed, but not in reverse order (e.g., */lg/, */lb/, */rd/, and */rk/)[1]. Problematically, sequences such as */pw/ and */tl/ are not allowed tautosyllabically in English even though the sonority relationship is respected (i.e., the first consonant has less SV structure than the second). Sonority alone is not enough to explain why such sequences are impossible.

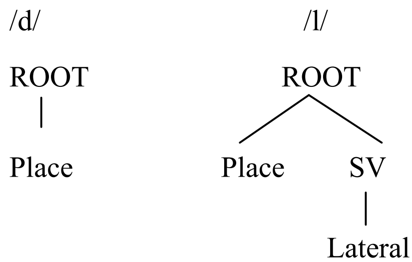
Therefore, Rice argues that segments in consonant clusters must have different place structures (that is, they must NOT be bound), as in the sequence /pl/ (where /p/ has more place structure than /l/) or /tw/ (where /t/ has less place structure than /w/). According to Rice, the government relationship in (28) between consonants in (30) is respected: /l/ is governed since /p/ has less SV-structure than /l/. In terms of the binding relationship in (28), /l/ is not bound because both consonants differ in place of articulation; thus, this cluster can be syllabified tautosyllabically.

(30) Tautosyllabic (within-constituent, or complex onset) structure



In contrast, clusters such as */pw/ and */tl/ are ruled out tautosyllabically because of a constraint against consonants being bound, or sharing place of articulation (i.e., the Obligatory Contour Principle). For example, consider the following sequence:

(31) Heterosyllabic (between constituent, or coda-onset) structure



Similar to the /pl/ sequence in (30), the government relationship in the /dl/ cluster is not violated as /d/ governs /l/. Nevertheless, both consonants must be syllabified heterosyllabically (coda + onset)since both segments have equal

(1) Notice that sequences such as /pn/ or /kn/ are not possible tautosyllabically because these sequences, given the sonority scale in (25) (25), violate the minimal sonority distance (MSD) between two consonants in an onset. MSD is said to be *two* in English (see, Clements, 1990). The MSD is irrelevant for Arabic, which has no complex onsets.

place structures; that is, /l/ is bound by /d/.

To summarize, the syllabification of consonants in clusters is dependent not only on the sonority (SV-structure) of these consonants, but also on their internal place structure. Relations between consonants are characterized as government and binding relations.

Following major assumptions in Rice's work, consonant clusters in Arabic's super heavy syllable (i.e., CVCC) will be accounted for using government and binding relationships that exist between segments in consonant clusters. Nevertheless, some modifications to the concepts of government and binding must be implemented in order to provide a better explanation for the Arabic data.

D. Modifications to *government*

In subsection C, the concepts of government and binding as presented in Rice's work have been introduced. In this section, a model that should account for the relationships between word-final consonant clusters in Arabic CVCC syllable(using Rice's basic assumptions) will be developed. This model requires a more detailed sonority scale than the one in (25)(25).

1. A more detailed sonority scale

The sonority scale in (25) shows that obstruents are the least sonorous segments on the scale. However, following Selkirk (1984), it will beassumed that fricatives are more sonorous than stops in Arabic, and the sonority profile to be followed is shown in (32):

(32) Detailed Sonority Scale

Least sonorous stop < fricative < nasal < liquid < glide < vowel Most sonorous

The following sonority ranking is based on Clements (1990) and Selkirk (1984). It is assumed that [±continuant] is contrastive only for obstruents; the non-contrastive feature values of [±continuant] are therefore omitted from the representation of sonorants in the following sonority scale:

(33) Clements' Sonority Rank

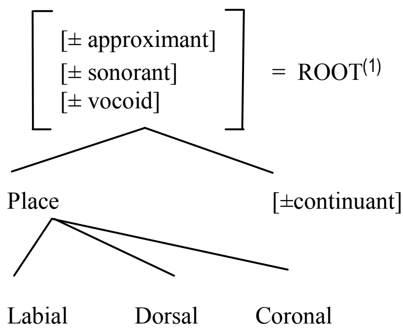
	[sonorant]	[approximant]	[vocoid]	[continuant]	sonority rank
Stop	-	-	-	-	0
Fricative	-	-	-	+	1
Nasal	++	-	-		2
Liquid	++	+	-		3
Vocoid	++	+	+		4

As shown in (1), vocoids are the most sonorous of all segments as they have more positive features and obstruents are the least sonorous as they have no positive features. Fricatives are [+continuant], whereas, stops are [-continuant]. Having one positive value, fricatives become more sonorous than stops. Finally, to ensure that nasals are more sonorous than fricatives, it will be assumed that the presence of [+sonorant] adds '2' to the sonority scale. (This is the reason for the extra '+' mark under the feature [sonorant] in (1)). This seemingly *ad hoc* mechanism is needed to account for the difference between plosives and fricatives. Note that Rice's model does not capture the distinction between plosives, fricatives, and nasals. In this model, both plosives and fricatives lack an SV node, whereas nasals have one. Still, there is no straightforward way to account for the greater sonority of fricatives than plosives by using Rice's structural account of the SV node. Therefore, it will be shown that the sonority ranking in (1)is vital to the current discussion of the data.

2. Segment structure or *feature geometry*

As proposed by Rice (1992) (see, (23) above), the segment structure will not be used in this paper; instead, Clements & Hume's (1995) feature geometry model of consonants will be adopted (with one addition for pharyngeals, later in example (50)). (Note that only features relevant to government and binding are shown).

(34) Consonantal representation



---

(1) Inspired by Clements & Hume's feature geometry, the segmental representation in (34) shows that the ROOT node (cf. (23)) contains the following features: [± approximant], [±sonorant], and [± vocoid].

In (34), the ROOT node contains the features: [± approximant], [±sonorant], and [± vocoid]. (Where convenient, instead of listing these features, the term ROOT will be used.) The ROOT node corresponds to Rice's ROOT and SV nodes. The Coronal, Dorsal, and Labial nodes are attached immediately to the Place node. (The Peripheral node in Rice's model is not used in Clements & Hume's model.) The Laryngeal and Supralaryngeal nodes in Rice's model are omitted in (34)because they are irrelevant for the present purposes.

While the Rice and Clements & Hume models are somewhat different, in both models, more structure still corresponds to greater sonority and vice versa.

Having presented some modifications to the sonority scale in (25), and Rice's segmental representation in (23), it becomes possible to formulate definitions for government and binding relationships in CVCC syllables in Arabic.

E. *Government* and *binding* in word-final CVCC syllables

1. Government

In this subsection, government relations between consonant clusters in CVCC syllables and the directions of government will be highlighted; however, before going any further, let us consider the major assumptions adopted in the discussion thus far:

(35) Government assumptions adopted (repeated here for convenience)

(a) Between-constituent government (see, (8) above)

(i) Coda + onset (9), or onset-to-onset (modified CLP (13)-- sonority-based government; sonority calculated as in (1); direction important (C3 governs C2).

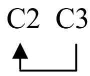
(ii) Nucleus-to-nucleus(9) -- direction important; depends on whether nucleus is empty or not (see, the ECP in(16))

(iii) Nucleus-to-onset (9) -- direction important (nucleus governs onset)

With respect to (35), it will be assumed that in order to establish a government relationship within consonant clusters in CVCC syllables, the two final consonants must not have the same level of sonority (cf. SCL); and, that the final consonant (i.e., onset C3) must govern the preceding one (i.e., onset C2, see (13) above), which also means that the direction of government must go from right to left. Therefore, the government relationship between word-final consonant clusters in CVCC syllables can be defined as in (36). ('C3' and 'C2' refer to the labels in (13)).

(36) Government relationship (see, also example (13))

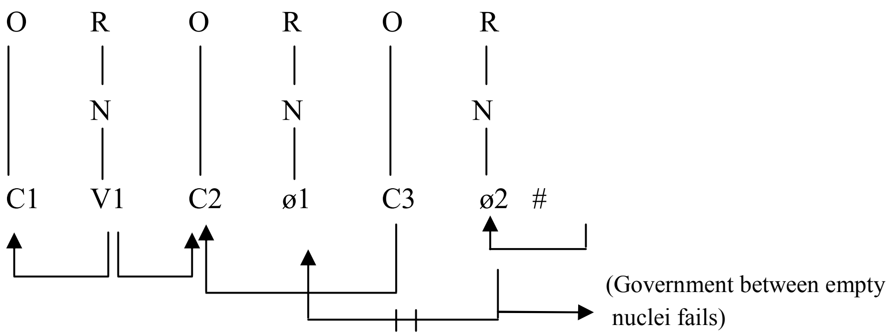
Government: C3 governs C2 if C3 has fewer positive values of sonority features than C2:



Given the above assumptions, it becomes possible to discuss how word-final consonant clusters should be represented in Arabic.

The way empty nuclei in CVCC syllable are tackled within the framework of GP has been presented in subsection. Recall that between-constituent government entails that government can also hold between contiguous nuclei (see,(9) above); thus, given what we know so far, it will be assumed that government in a CVCC syllable would yield the following abstract representation (i.e., CVCøCø):

(37) CVCC syllable structure (underlying representation)



Based on government relationships presented in the GP system, and the definition of government in(28), C3 can govern C2 if the relevant conditions on government are met (i.e., if C3 has less sonority than C2). On the other hand, V1 (a full vowel) governs C1 (between-constituent government) and C2 (within-constituent government). Furthermore, the final empty nucleus (i.e., ø2) is prosodically-licensed by domain-final position (i.e., #; see (18) above); thus, it cannot be a governor (given proper government in (17)). Government of the empty nucleus ø1 will be discussed in subsection IV.A..

2. Binding

The binding relationships between consonant clusters in Arabic's CVCC syllables will be described in this subsection. Based on their phonemic inventories, internal place-structures for LA, JA, and AA consonants will be suggested, and special attention will be given to coronal segments.

(a) a. *Place structure of Arabic consonants*

Based on Rice's (1992) proposal, it has been shown that consonants in clusters exhibit binding as well as government relationships and that together they dictate the way these consonants should be syllabified. In this subsection, it will be argued in favor of this proposal (it will also be added in section IV.A. that these relationships dictate the alternation between epenthetic [i] and empty [ø] nuclei in CVCC in LA).

Place structures for different Arabic segments will be proposed in this subsection. However, some modifications to binding, as proposed in Rice's (1992) work, become necessary in order to account for the relationship between consonant clusters in CVCC syllables. The table in (38) presents the consonantal phonemic inventories for JA, AA, and LA:

(38) Consonantal phonemic inventories of LA, JA, and AA

	Labial	Labio-dental	Inter-dental	Dental	Alveolar	Palatal	Velar	Uvular	Pharyngeal	Glottal
Stop	b			t d			k g(1)	(q)(2)		ʔ
Emphatic stop				ṭ D(3)						
Fricative		f	θ ð(4)		s z	ʃ ʒ	x ɣ		ħ ʕ	h
Emphatic fricative			Đ(5)		ṣ z(6)					
Affricate						tʃ dʒ(7)				
Nasal	m				n					
Lateral					l					
Flap					r					
Glide	w					j				

----

(1) Velar [g] is attested in JA and AA only.
(2) Uvular stop is generally used in certain standard words.
(3) Emphatic [D] is attested in LA only.
(4) Fricatives [θ] and [ð] are not used in LA.
(5) Emphatic fricative [Đ] is not attested in LA.
(6) Emphatic fricative [z] is not attested in either JA or AA.
(7) Affricates are not attested in AA.

Under the Place node in(34), the major places of articulation to be discussed are labial, dorsal, and coronal, in addition to uvulars, pharyngeals, and laryngeals. Special attention, however, will be given to coronals as their structure is inventory-dependent.

b. Labials, dorsals, and uvulars

Following Clements & Hume (1995), the following place structures for Arabic consonants are assumed:

(39) Place structures of Arabic labials, dorsals, and uvulars

a. Labials [b, m, w, f]

ROOT
|
Place
|
Labial

b. Dorsals [k, g]

ROOT
|
Place
|
Dorsal

c. Uvulars [x, ɣ, q]

ROOT
|
Place
|
Dorsal

Both labials and dorsals are universally marked. Although both classes of segments have the same amount of Place structure, they are still not identical. Notice that uvulars and dorsals are differentiated by the feature [±high], where dorsals are considered as [+high]. Recall from(1) that LA, JA, and AA basically have no uvular [q] anymore (except in Standard Arabic pronunciation). The distinction between velars and uvulars is thus not relevant to the current discussion.

The place structure of pharyngeals and laryngeals is shown in (40) (see, McCarthy (1994) for Radical node):

(40) Place structure of Arabic pharyngeals and laryngeals

a. Pharyngeals [ħ, ʕ]

ROOT
|
Place
|
Radical

b. Laryngeals [h, ʔ]

ROOT

Pharyngeal sounds are produced with the root of the tongue pushing against the back wall of the pharynx. When laryngeal segments are produced, no place of articulation in the oral cavity is involved, thus laryngeals should have the least place structure of all sounds.

c. Coronals

Coronals' structural representations must be inspected carefully; therefore, different analyses will be overviewed in an attempt to arrive at the one that best provides reasonable account of the Arabic data.

Upon examining different phonological processes involving coronals, researchers have proposed various internal structures of these segments. For example, Paradis & Prunet (1989) argue that "coronals lack a place node altogether" (p.317). Their argument is based on examination of vowels spreading through intervening coronals in languages such as Fula, Guere, and Mau. Paradis & Prunet (1989) have come to a conclusion that coronals must be transparent(i.e., they have no place node), and proposed the Coronal Underspecification Principle (CUP):

(41) Coronal Underspecification Principle: Unmarked coronals universally lack a Place node

Coronals, under Paradis & Prunet's analysis, would have the following representation:

(42) Coronal representation based on CUP

ROOT

Notice that according to CUP, coronals will not be different from laryngeals in (40), as far as their place structure is concerned: they both lack a Place node.

Based on assimilation processes involving coronals, researchers such as Avery & Rice (1989) argue that unmarked segmental features are absent from Underlying Representations (UR). Similarly, Yip (1989) argues that only distinctive features are specified underlyingly. Thus, since coronal is the unmarked place of articulation, it must be absent from the UR (unspecified lexically); in contrast, labial and dorsal segments are marked and thus should be present in UR:

(43) Marked vs. Unmarked segments

a. Coronals (unmarked)

ROOT
|
Place

b. Labials (marked)

ROOT
|
Place
|
Labial

c. Dorsals (marked)

ROOT
|
Place
|
Dorsal

Note that in (43), Avery & Rice's analy-sis of coronals' internal structure posits more structure than that of Paradis & Prunet (cf. (42)). Both options will be utilized for LA, as will be described later.

Avery & Rice propose that if further features of a coronal are needed, additional node(s) can be activated beneath the Place node, and they introduce the Node Activation Condition (NAC):

(44) Node Activation Condition:

If a secondary content node is the sole distinguishing feature between two segments, then the primary feature is activated for the segments distinguished. Active nodes must be present in underlying representation (p. 183).

For example, a distinction between the coronals [s], [z], [ʃ], and [ʒ] can be made if the distinctive feature [±anterior] is used, where [s] and [z] are [+anterior] and [ʃ] and [ʒ] are [-anterior]. According to the NAC, the primary feature for [±anterior] (i.e., Coronal) must then be activated as shown in (45):

(45) Examples of NAC

[s]	[z]
ROOT	ROOT
|	|
Place	Place
|	|
Coronal	Coronal
|	|
[+anterior]	[+anterior]

[ʃ]	[ʒ]
ROOT	ROOT
|	|
Place	Place
|	|
Coronal	Coronal
|	|
[-anterior]	[-anterior]

According to the NAC, distinctions between sibilants [s], [z], [ʃ], and [ʒ] would not be possible to make unless a secondary node is activated (i.e., [±anterior])(1). As we will see shortly, the NAC becomes important to our discussion of the Arabic data; thus, it will be adopted.

Therefore, it is assumed that many coronals in Arabic lack a node beneath the

(1) Paradis & Prunet (1989) argue that [+anterior] is the unmarked specification for [anterior]; therefore, it may not be included in the segmental representation for [s] and [z]. In this paper, however, this unmarked feature will be included, if needed, in the segmental representation of either [s] or [z].

Place node in UR. However, if further distinction is called for, one or more nodes can then be activated. Based on this, the following place structures for Arabic coronals are assumed:

(46) Various place structures of Arabic Coronals

a. [t, d, ṭ, D, s, z, ṣ, z, j]

ROOT
|
Place

b. [n, r]

ROOT
|
Place
|
Coronal

c. [l]

ROOT
|
Place
|
Coronal
|
[+lateral]

d. [ʃ, ʒ, tʃ, dʒ]

ROOT
|
Place
|
Coronal
|
[-anterior]

Under this assumption, the liquid [l] must be differentiated from the other liquid [r]; that is, following Blevins (1994) (cited in Yip, 2005), the feature [+lateral] must be activated for [l] giving it more place structure than [r]. It is also assumed that the segments [n, r] would be different from other coronals in that they have the Coronal node with no further dependents hanging beneath it(the assumed place structure for [n, r] in (46) will turn out to be the most convenient representation).

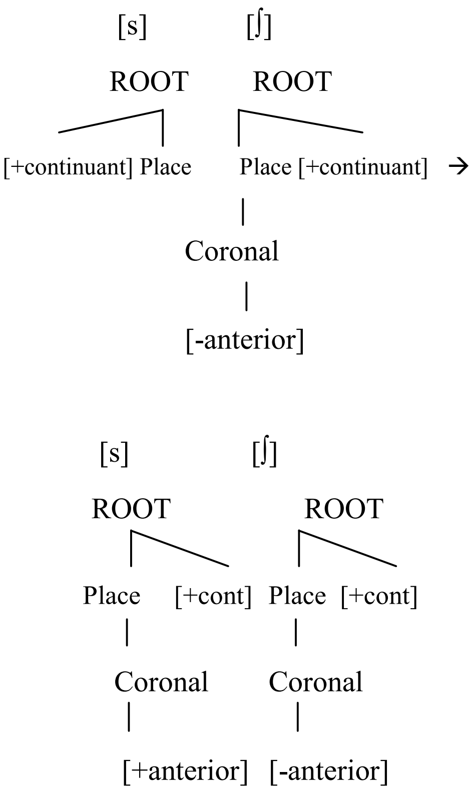
It is further assumed that segments such as [t, d, s, z] would only have the Place node in their structure without dependents. There is one important caveat, however. It is assumed that representations between adjacent sibilants are determined syntagmatically. (Similarly, on coronal transparency phenomenon, Clements (2001) proposes that "the feature [coronal] is specified in the phonology only if it figures as a term in constraints, and is projected to a separate tier only if it is phonologically prominent" (p. 115)). For example, when [s] and/or [z] happens to occur in one cluster with [ʃ] and/or [ʒ], then all related distinctive features must be activated in order to distinguish between such segments[1].

(47) Syntagmatic NAC: the development of secondary nodes which bear distinguishing features between two adjacent segments.

Consider the following example:

(1) Recall that NAC in (44)entails the presence of Coronal and dependent nodes (i.e., [± anterior]) for segments such as [s, z, ʃ, ʒ]; however, in (45), it is assumed that the Coronal node is not activated for these segments unless it becomes necessary.

(48) The development of distinctive nodes in cluster [sʃ]

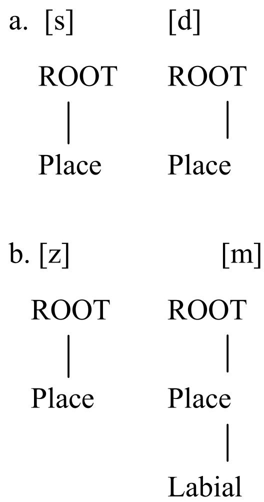


In (48), the segments [s] and [ʃ] in the cluster [sʃ] are distinguished by activating the Coronal and [±anterior] nodes. Notice that in the cluster [ʒz], for instance, the same set of nodes is developed.

It is further argued that if [s] and/or [z] form a cluster with any other segment (i.e., non-sibilant), then there is no need to activate any further

distinctive nodes. Consider, for example, the following representations for clusters [sd] and [zm]:

(49) Segmental structure of sibilant+ non-sibilant

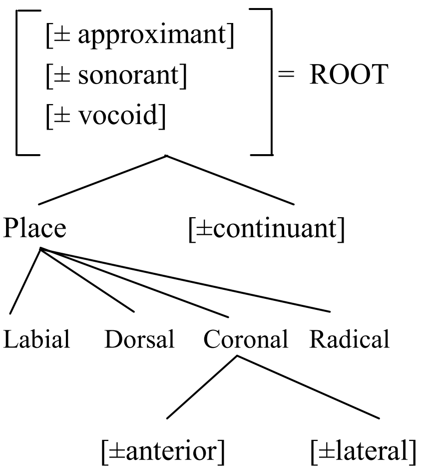


Note that no additional nodes have been activated beneath the Place nodes of [s] and [z] in (49). Further distinctions

between segments in these clusters are not necessary, since [s] and [d], for example, are also distinctively [± continuant].

Up to this point, our complete segmental representation can be sketched as in (50):

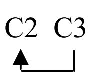
(50) Consonantal representation of Arabic (modified)



Given the special status of coronals, we notice that two binary features (i.e., [± anterior] and [±lateral]) are added beneath the Coronal node, as the representation in (50) shows.

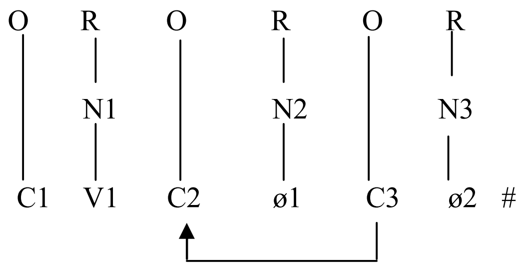
Having assumed place structures for Arabic consonants, the following *binding* relationship between consonant clusters in CVCC syllables will be proposed, where the direction of binding goes from *right to left* (cf. definition in (28)); (‘C3’ and ‘C2’ refer to the labels in (52)):

(51) Binding: C3 binds C2 if C3 has identical or less place structure than C2:



This definition indicates that the binding relationship between two consonants in a cluster is respected if (a) both consonants share the same place of articulation or (b) if C3 has less place structure than C2. Under (51), binding in Arabic word-final CVCC syllables should operate as in (52) below:

(52) Binding in Arabic CVCC syllable structure



According to the definition in (51), C3 binds C2if C3 has less than or identical place structure in comparison to C2. As will be shown shortly, one advantage of this assumption shows that binding (or lack of binding) will help predict whether or not [ø1] in (52) is realized as an epenthetic full vowel (e.g., [i] in LA).

To recapitulate, government and binding relationships in Arabic word-final consonant clusters in CVCC have been formulated. To help characterize these relationships, some modifications have been suggested to the original concepts in Rice’s (1992) work. Consonants C2 and C3 in (52) are both “onsets” in GP. C3 governs and binds C2 because the relationship between them was basically proposed as coda-onset government, where C2 is the "coda"; however, this relationship is reanalyzed in this paper as onset-onset government (as stated earlier). The empty nucleus N3 in (52) is always inaudible because it is P-licensed. It will be argued in the next section that N2 can be realized as either empty [ø] or full vowel [i] in LA, depending on government and binding relationships.

In the next section, the relationships between word-final consonant clusters in Arabic CVCC syllables will be analyzed along the lines of government and binding. It will be shown that government and binding, as presented throughout this paper, are not relevant to epenthesis and lack of epenthesis in either JA or AA. However, epenthesis and no epenthesis in the LA data will be shown to have stemmed from both government and binding relationships; thus, a subsection will be devoted to the LA data alone.

IV. The analysis

Thus far, definitions for government and binding relationships between consonant clusters in CVCC syllables have been provided. Similarly, the internal structure of Arabic consonants have been presented. This section begins by reminding the readers of the states of epenthesis and lack of epenthesis in the three dialects of Arabic.

We have seen in section II that in JA an epenthetic vowel is inserted between any two consonants in a cluster across the board. To the contrary, AA does not allow epenthesis to apply between consonants in the same set of clusters. LA, on the other hand, shows variation between epenthesis and no epenthesis between word-final consonant clusters in CVCC syllables.

The two extreme views of epenthesis and lack of epenthesis in JA and AA, respectively, denote that government and binding relationships are not relevant for word-final consonant clusters in CVCC syllables in either dialect. Nevertheless, the JA and AA data will still be discussed further in section V.A..

Next, it will be shown that variation between epenthesis and no epenthesis in LA can be explained along the lines of government and binding, as proposed in this paper.

A. The LA data

Based on how much conformity LA data shows to conditions of government and binding, most clusters can be organized into five categories:

(53) Categories in LA data

a. Both government and binding are respected: [wm, wz, jt, wd, lm, lf, rs, mz, ns, lb, ld, md, nt, ṣṭ, ʃṭ, ʒd, ft, ls].

b. Government is respected, but not binding: [wl, jl, jr, jn, jb, jk, wr, rf, ṣb, rb, rk, nk, zb, zk, fk, lʒ, rʒ, nʒ, jʃ].

c. Binding is respected, but not government: [fs, bs, ds, kz, kt, kd, bd, bṭ].

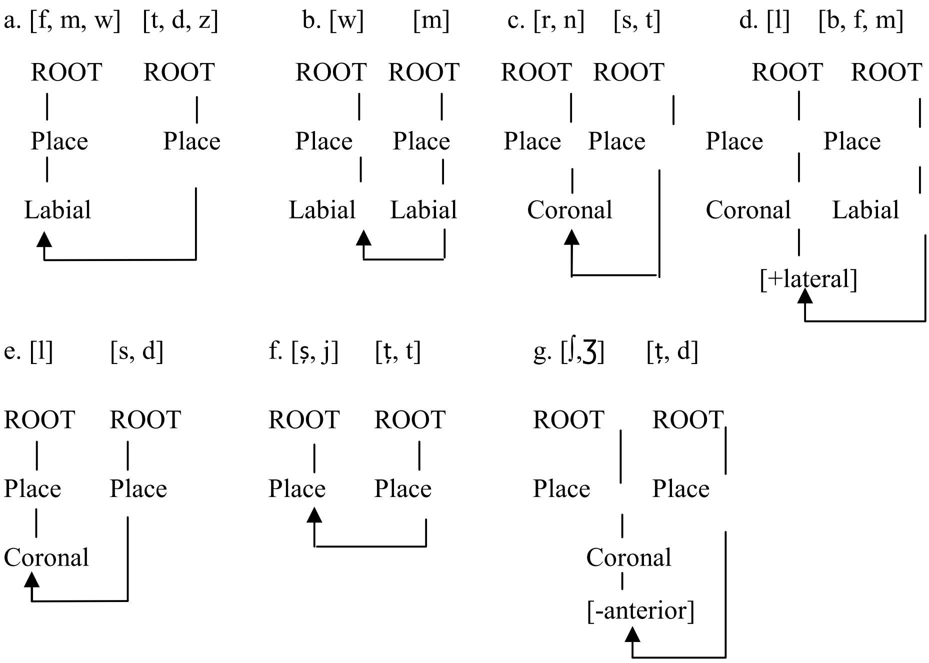
d. Neither government nor binding is respected: [rl, nl, ml, sl, fl, kl, sr, fr, br, kr, tm, sm, km, mn, fn, ṣn, bn, kn, sf, tf, kf, sʒ, sʃ, bk, tk, db, kb, ʒz].

e. Exceptions: [rm, rn, fʃ, mr, ṭʃ, ʒf].

No epenthesis applies in CVCC clusters in categories (a), (b), and (c); epenthesis, however, applies in category (d), which violates both government and binding relationships.

The clusters in category (53) respect government and binding relationships as defined in(36) and (51) above. This is also shown in (54), where arrows indicate binding relationships:

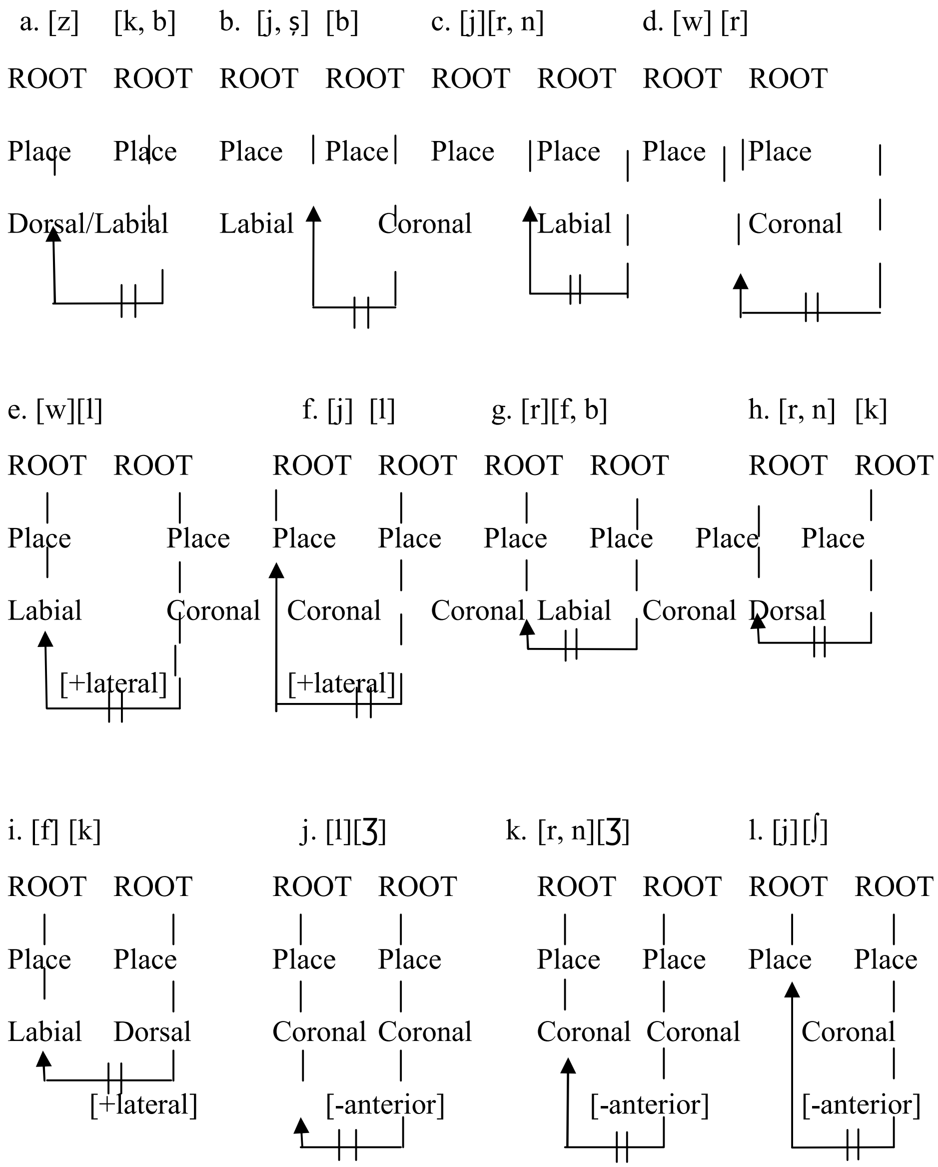
(54) Government and binding relationships are respected



Both government and binding relationships are respected in each cluster in (54). All final consonants (C3) have fewer positive values of sonority features and less place structure than or identical place structure to the preceding ones (C2); therefore, C3 both governs and binds the preceding C2.

The consonant clusters in (53), however, respect government, but not binding. Consider example (55), where lack of binding is shown:

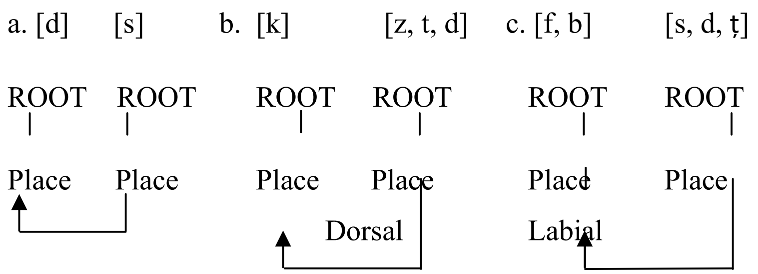
(55) Government is respected; binding is violated



Each cluster in (55) respects government in the sense that all final consonants (C3) have fewer positive sonority features than the previous ones (i.e., C2). Binding relationships, on the other hand, are violated: all final consonants (C3) have different or more place structures than the preceding ones (i.e., C2).

The clusters in (53) show violation of government relationship between consonants; however, binding is respected. For example:

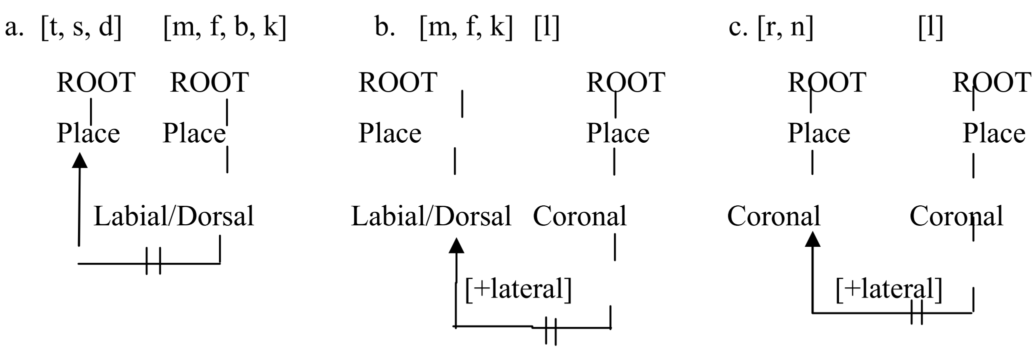
(56) Government is violated; binding is respected

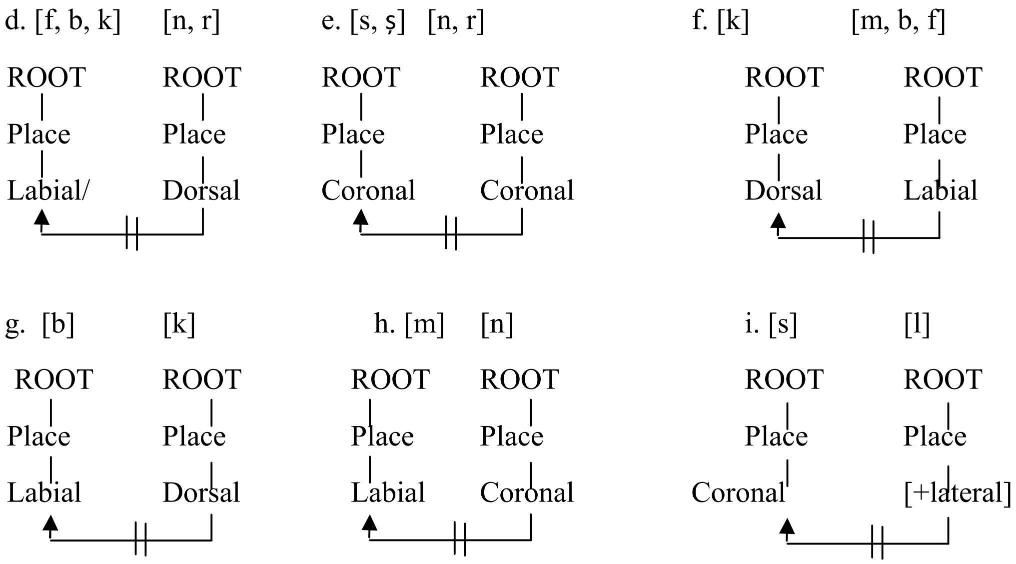


In these clusters, government is violated as C3 has more sonority than C2. Binding relationships, however, are not violated: Final consonants C3 have either less or identical place structure to preceding segments C2; thus, they are bound.

Now, consider the clusters in category (53). (Note that three clusters from (53) are explained in (58)). In each cluster, both government and binding relationships are violated. Example (57) illustrates lack of binding relationships.

(57) Government and binding relationships are violated

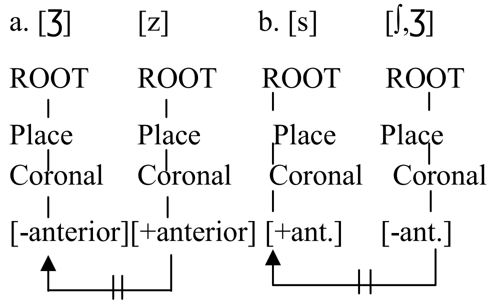




The clusters in this category violate both government and binding relationships between consonants. In each cluster, final consonants cannot govern nor can they bind the preceding consonants: they have more feature values of sonority, and also more or non-identical place-features to the preceding consonants; therefore, conditions on both government and binding relationships are violated. We notice that an epenthetic vowel is inserted between C2 and C3 in these clusters.

Finally, consider the following remaining clusters from (53). Assuming the syntagmatic NAC in (47), such clusters are similar to the other clusters in (53) in the sense that they violate both government and binding relationships. Lack of binding is shown in (58).

(58) Syntagmatic NAC examples



As mentioned earlier, no epenthesis applies in the first three categories (i.e., a-c in (53)), illustrated in (54) - (56)); however, in the fourth category (53), illustrated in (57) and (58)), an epenthetic vowel is inserted between consonants in each cluster. Based on this initial classification of the data, the researcher assumes that epenthesis in LA is a repair strategy implemented when condition(s) on BOTH government and binding relations between C2 and C3 in CVCC syllable are violated (e.g., category (53)). Therefore, epenthesis in LA CVCC syllable can be formulated as in (59):

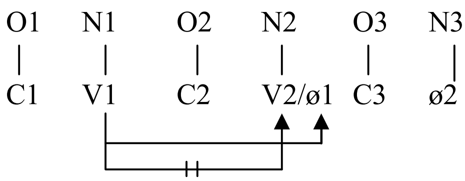
(59) Epenthesis in LA's CVCC syllable structure

There is no epenthesis (a) if government requirements are met and/or (b) if binding requirements are met.

The assumptions in (59) entail that conditions on both government and binding must be violated in order for epenthesis to occur. They also entail that if either government and/or binding is respected, epenthesis must not apply.

Therefore, it can be assumed that epenthesis of [i] in LA reflects a violation of nucleus-to-nucleus government (hence, vowel-to-vowel (V-V) government). In other words, if either government and/or binding is not violated between word-final consonant clusters, then the full vowel governs the contiguous empty nucleus as the following illustration shows:

(60) V-V government



Depending on government and binding, the relationship between N1 and N2 produces two possibilities as shown in (60). The first possibility states that if government and/or binding is respected between onsets C3 and C2, then N1 (full vowel) succeeds in governing N2 (empty nucleus) thus rendering it inaudible (i.e., ø1). The second possibility states that if BOTH government and binding relations between C3 and C2 are violated, then the nucleus in N2 is phonetically realized as a full vowel (e.g., V2), which also means that V1 fails to govern N2.

The assumptions in (59) account for almost all patterning of clusters in LA, except the six clusters in (53) which remain problematic for these assumptions.

Next subsection provides an account for the data from all three dialects (JA, AA, and LA) within an Optimality theoretic framework. For this purpose, different constraints must be proposed using major assumptions, such as government and binding (among others), which have been developed in the discussion so far.

B. Optimality Theory (OT)

1. General description

Thus far, it has been shown that AA, JA, and LA differ with regard to the way they deal with epenthesis in CVCC consonant clusters. AA, for example, does not tolerate epenthesis. JA, on the other hand, allows epenthesis across the board. Between these two extreme treatments, epenthesis in LA is dependent on the fulfillment of government and binding conditions.

In this subsection, a comprehensive analysis of epenthesis and no epenthesis variation in all three dialects is provided in light of Prince & Smolensky's Optimality Theory(OT) (2004) [originally appeared in 1993], where a constraint-based analysis of the data is assumed.

In OT, a set of universal constraints are placed on the surface phonological form (output). These constraints ensure that the best output form survives. Constraints in this theory are ranked; that is, one constraint will have priority if it is ranked higher than another constraint. Constraints are violable in that a constraint can be violated in order to satisfy a higher ranked constraint. In this framework, languages differ in the way they rank constraints.

Utterances in OT go through two mechanisms, the Generator (GEN) and Evaluator (EVAL). GEN generates an infinite set of output candidates. EVAL, on the other hand, chooses the candidate that best satisfies a set of ranked constraints. The candidate with the least violations of constraints (etc.) becomes the optimal candidate.

In the following paragraphs, a set of constraints which will be necessary for explaining the data from AA, JA, and LA will be provided. These constraints are derived from the discussion we have had so far.

2. Constraints needed

Constraints in EVAL are of two types: markedness and faithfulness constraints. Markedness constraints impose conditions on the well-formedness of the output, ensuring that outputs which are marked are disfavored. Faithfulness constraints, on the other hand, require that input and output forms are identical; for example, all consonants in the input must appear in the output.

a. Markedness constraints

The government in (61a) and binding in (61b) relationships between word-final consonant clusters are markedness constraints. Another related constraint is *Complex (61c)which prevents certain consonant clusters:

(61) Markedness constraints

a. Coda-onset government: sonority conditions must be respected (C-O GOVT).

b. Coda-onset binding: place-structure conditions must be respected (C-O BIND).

c. *Complex: no more than one consonant in a row.

It can then be assumed that *Complex applies to word-final consonant clusters, however the way they are analyzed.

b. Faithfulness constraints

Two constraints related to epenthesis are DEP and Vowel-to-Vowel government:

(62) Faithfulness constraints

a. DEP: Do Not Epenthesize.

b. Vowel-to-Vowel (V-V) government: an audible nucleus must not be governed.

The DEP constraint prevents epenthesis of a vowel in consonant clusters. The (V-V) constraint ensures that an empty nucleus remains silent if governed by a contiguous full vowel, and audible otherwise (cf. ECP).

V. The OT analysis

This section provides a complete analysis for the data in each dialect using faithfulness and markedness constraints.

Knowing that government and binding relationships are irrelevant to epenthesis in AA and JA, respectively, constraints related to such relationships will not be used to account for the AA and JA data (that is, as one assumes, they are lower-ranked). Instead, two constraints, DEP and *Complex, will be relevant:

A. OT explanation of AA and JA

Tableaux (63) and (64) account for the AA and JA data.

(63) AA (no epenthesis)

/CVCC/	DEP	*Complex
☞[CVCC]		*
[CVCiC]	*!	

(64) JA (epenthesis)

/CVCC/	*Complex	DEP
[CVCC]	*!	
☞ [CVCiC]		*

Upon comparing tableaux (63) and (64), it can be noticed that the two constraints are ranked differently in each dialect (ranking is indicated by left-to-right ordering of the constraints' columns). In AA, DEP is ranked higher than *Complex; whereas, in JA, *Complex is ranked higher than DEP. The violation of DEP in AA (indicated by the asterisk at the intersection of column DEP and row [CVCiC]) becomes a serious violation (indicated by the exclamation mark next to the asterisk), which renders CVCC (no epenthesis) the right choice, (indicated by the pointing hand). To the contrary, violation of the constraint *Complex in JA constitutes a more serious violation since it is ranked higher than DEP; thus, the second choice (epenthesis)is the right one for JA.

In conclusion, the difference between

these two dialects with regard to epenthesis can be captured in the way the constraints DEP and *Complex are ranked in each dialect. Next, an account for LA data will be provided. For this dialect, it becomes necessary to add government, binding, and V-to-V constraints (61 a-c).

B. OT explanation of LA

As has been shown earlier, LA shows a more complicated picture. In simple words, it is assumed that epenthesis is expected to occur in word-final CVCC consonant cluster only if the conditions on both government and binding are violated. No epenthesis, however, is expected if the conditions on government alone and/or binding alone are violated. Four different tableaux are necessary to capture the variation between epenthesis and no epenthesis in LA. In each tableau, constraints are ranked in the following fixed order:

(65)

[C(oda)-O(nset) GOVT
C-O BIND
DEP] >> V-to-V >> *Complex

The way constraints C-O GOVT, C-O BIND, and DEP are displayed denotes that these constraints are equally ranked. Moreover, these constraints are ranked higher than V-to-V, which is higher than *Complex in the hierarchy.

The first tableau in (65) shows an example of no epenthesis where the conditions on both government and binding relationships are respected (cf. (53a)). Note that constraints C-O GOVT, C-O BIND, and DEP are separated by dotted line, which means that they are equally ranked. The constraints V-to-V and *Complex, on the other hand, are separated by solid lines, which means that their ranking is crucial with respect to one another. (H refers to *higher sonority*; L means *lower sonority;* M means *more structure*; L refers to *less structure*):

(66) Government and binding are respected (no epenthesis (53a))

	CC HL (GOVT) ML (BIND)	C – O GOVT	C – O BIND	DEP	V-to-V	*Complex
☞	C ø C ø H ø L ø M ø L ø					*
	C i C ø H i L ø **M** i L ø			*!	*	

The first candidate in tableau 0 with no epenthesis violates one constraint only (i.e., *Complex); in contrast, the second candidate with epenthesis violates two constraints: DEP and V-to-V. The first candidate wins because constraint *Complex is ranked lower than DEP and V-to-V in the hierarchy; thus, violation of this constraint is not as serious as the violation of DEP. We notice that a DEP violation entails a violation of V-to-V government.

The second tableau in (67) describes a state of no epenthesis where government is respected, but binding is violated (cf. (53b)).

(67) Government is respected; binding is violated (no epenthesis (53b))

	CC HL LM	C - O GOVT	C- O BIND	DEP	V-to-V	*Complex
☞	C ø C ø H ø L ø L ø M ø		*			*
	C i C ø H i L ø L i M ø			*	*!	

Although the first candidate (no epenthesis) is the preferred choice, it still violates two constraints: C-O BIND and *Complex. The second candidate (with epenthesis), however, violates DEP and V-to-V. We have seen that constraints C-O BIND and DEP are ranked equally, which means that violation of one is equal to violation of the other. Therefore, the preference of the first candidate comes as a result of the serious violation of the constraint V-to-V by the second candidate.

The third tableau in (68) expresses cases where government is violated, but binding is respected (cf. (53c)).

(68) Government is violated; binding is not (no epenthesis (53c))

	CC LH ML	C-O GOVT	C-O BIND	DEP	V-to-V	*Complex
☞	C ø C ø L ø H ø M ø L ø	*				*
	C i C ø L i H ø **M** i L ø			*	*!	

As such, it can be deduced that when government alone is violated, no epenthesis applies. Therefore, the first candidate (no epenthesis) is picked as the best choice. As seen in tableau 0, violations of the constraints G-O GOVT and DEP will not be decisive as they will not decide between one candidate and the other. However, violation of the constraint V-to-V rules out the second candidate.

The fourth tableau in (69) shows that conditions on both government and binding relationships are violated (cf. (53d)).

(69) Government and binding are violated (epenthesis (53d))

	CC LH LM	C-O GOVT	C-O BIND	DEP	V-to-V	*Complex
	C ø C ø L ø H ø L ø M ø	*	*!			*
☞	C i C ø L i H ø L i M ø			*	*	

Thus far, it can be deduced that epenthesis applies when both government and binding conditions are violated. In tableau (69), the second candidate (with epenthesis) is the best choice. The first candidate violates three constraints: C-O GOVT, C-O BIND, and *Complex. Violation of the two equally ranked constraints (C-O GOVT and C-O BIND) presents a serious violation, in addition to the violation of the constraint *Complex. Thus, the second candidate wins with two violations only.

VI. Conclusion:

In this paper, the researcher has presented and discussed segmental relationships between consonant clusters in Arabic CVCC syllable types. This type of syllable is attested to in Standard Arabic as well as in many contemporary spoken dialects of Arabic. The focus of this paper, however, has been on three dialects of Arabic: JA, LA, and AA.

Each dialect deals with consonant clusters in this particular syllable differently; that is, an epenthetic vowel is always inserted between word-final consonant clusters (i.e., JA); AA, on the other hand, does not allow any epenthetic vowel to intervene between consonants in the same cluster. LA, however, varies between these two extreme views of absolute epenthesis vs. no epenthesis.

Building on premises and principles of Rice (1992), and GP, as proposed by KLV, it has been shown that states of epenthesis/no epenthesis in LA are not random but rather, conditioned by government and binding relationships. These relationships dictate the syllable formation of consonant clusters in final CVCC syllables.

Towards the end of this paper, a more comprehensive explanation of epenthesis in all three dialects based on the framework of OT has been provided. This paper aspires to contribute to phonological studies on Arabic, and hopes to enrich the literature of GP, in particular.

Bibliography

Abu-Mansour, M. (1991). Epenthesis in Makkan Arabic: Unsyllabified consonants vs. degenarate syllables. In B. Comrie, & M. Eid, *Perspectives on Arabic Linguisitcs III: Papers from the third annual symposium on Arabic linguisitcs* (pp. 137-154). Philadelphia: John Benjamins Publishing Company.

Abu-Salim, I. & Abd-el-Jawad, H. (1988). Syllable patterns in Levantine Arabic. *Studies in the linguistic sciences, 18,* (2), 1-22.

Angoujard, J. P. (1990). *Metrical structure of Arabic.* Boston, MA: Walter de Gruyter.

Avery P. & Rice, K. (1989). Segment structure and coronal underspecifi-cation. *Phonology, 6,* 179-200.

Cairns, C. & M. Feinstein (1982). 'Markedness and the Theory of Syllable Structure'. *Linguistic Inquiry* 13, 193-226.

Carlisle, Robert S. (1998). The acquisition of onsets in a markedness relationship. *Studies in Second Language Acquisition, 20,* 245-60.

Carlisle, R. S. (2001). Syllable Structure Universals and Second Language Acquisition. International Journal of English Studies, 1 (1), 1-19.

Charette, M. (1990). Licensing to govern. *Phonolgy, 7,* 233-253.

Clements, G. N. (1990). The role of the sonority scale in core syllabification. In J. Kingston & M. E. Beckman (Eds.), *Papers in laboratory phonology I: Between the grammar and physics of speech* (283-333). Cambridge: Cambridge University Press.

Clements, G. N. & E. V. Hume (1995). Internal organization of speech sounds. In J. A. Goldsmith (Ed.), *The handbook of phonological theory* (245-306). MA:

Blackwell Publishing.

Clements, G. N. (2001). Representational economy in constraint-based phonology. In T. A. Hall (Ed.), *Distinctive feature theory* (71-146). NY: Mouton de Gruyter.

Hyman, L. M. (2008). Universals in phonology. *The Linguistic Review*, 25.83-137.

Kaye, J. (1990). 'Coda licensing'. *Phonology, 7,* 301-330.

Kaye, J., Lowenstamm, J., & Vergnaud, J. (1990). Constituent structure and government inphonology. *Phonology, 7,* 193-231.

Kenstowicz, M. (1994). *Phonology in generative grammar*. Cambridge MA & Oxford UK: Blackwell.

Keyser, S. & Stevens, K. (2006). Enhancement and overlap in the speech chain. *Language, 82,* 33-63

Kiparsky, P. (2003). Syllables and Moras in Arabic. In C. Fery & R. van der Vijver (Eds.), *The syllable in Optimality Theory* (147-182). UK: Cambridge University Press.

Ladefoged, P. & Maddieson, I. (1996). *The sounds of the world's languages.* Oxford: Balckwell.

Mahfoudhi, A. (2005). Moraic syllable structure and edge effects in Arabic. In Alhawary, M (Ed.), *Perspectives on Arabic Linguistics XVII-XVIII: Papers from the seventeenth and eighteenth annual symposia on Arabic linguistics* (pp. 27- 48). Philadelphia: John Benjamins Publishing Company.

McCarthy, J. (1991). Semitic gutturals and distinctive feature theory. In B. Comrie & M. Eid (Eds.), *Perspectives on Arabic Linguistics III: Papers from the third annual symposium on Arabic linguistics* (pp. 63-91). Philadelphia: John Benjamins Publishing Company.

McCarthy, J. (1994). The phonetics and phonology of Semitic pharyngeals. In P. A. Keating (Ed.), *Phonological structure and phonetic form: Papers in laboratory phonology III* (191-233). NY: Cambridge University Press.

Murray, R. W. & T. Vennemann. 1983. Sound change and syllable structure in Germanic phonology. Language 59.514–528.

Paradis, C. & Prunet, J. (1989). On coronal transparency. *Phonology, 6,* 317-348.

Prince, A. & Smolensky, P. (2004). *Optimality theory: Constraint interaction in generative grammar*. MA: Blackwell Publishing.

Rice, K. (1992). On deriving sonority: A structural account of sonority relationships. *Phonology, 9,* (1), 61-99.

Rice, K. (1993). A reexamination of the feature [Sonorant]: The status of 'sonorant obstruents'. *Language, 69,* (2), 308-344.

Selkirk, E. (1981). Epenthesis and degenerate syllables in Cairene Arabic. In H. Borer & Y. Aoun (Eds.), *Theoretical issues in the grammar of Semitic languages* (pp. 209-232). MIT: Working Papers in Linguistics.

Selkirk, E. (1984). On the major class features and syllable theory. In M. Aronoff & R. T. Oehrle (Eds.), *Language Sound Structure: Studies in phonology presented to Morris Halle by his teacher and students* (pp. 107-136). Cambridge: MIT Press.

Van Mol, M. (2003). *Variation in modern standard Arabic in radio news broadcasts: A synchronic descriptive investigation into the use of complementary particles*. Walpole, MA: Peeters Publishers.

Vennemann, T. (1987). *Preference laws for syllable structure: And the explanation of sound change with special reference to German, Germanic, Italian, and Latin.* Boston, MA: Walter de Gruyter.

Watson, J. (2002). *The phonology and morphology of Arabic.* New York: Oxford University Press Inc.

Yip, M. (1989). Feature geometry and cooccurrence restrictions. *Phonology, 6*, 349-374.

Yip, M. (2005). Variability in feature affiliations through violable constraints: The case of [lateral]. In M. van Oostendorp & J. van de Weijer (Eds.), *The internal organization of phonological segments* (pp. 63-92). NY: Walter de Gruyter.

Yoshida, Y. (2003). Licensing constraint to let. In S. Ploch (Ed.), *Living on the Edge: 28 papers in honour of Johnathan Kaye* (pp. 449-464). NY: Mouton de Gruyter.