Chapter Two

The Syllable Structure of Casablanca Moroccan Arabic

1. INTRODUCTION

CMA has three underlying vowels which are [i, u, a] and an epenthetic schwa. The schwa is epenthesized to break up consonantal clusters that the language does not allow. While underlying vowels are not subject to any restrictions on syllable structure, schwas are problematic in a number of respects. First, unlike full vowels which can occur in both open and closed syllables, schwas never occur in open syllables. Second, the rule which epenthesizes a schwa has to refer to the syntactic category of the base. Thus the way schwas behave in verbs and adjectives, for example, is different from the way they behave in nouns. While the schwas occurring in verbs and adjectives can be accounted for by a structure-building algorithm of syllabification, nominal schwa epenthesis is dependent on the sonority of the consonants of the base. Third, in order to derive the correct output, schwa epenthesis should be allowed to apply cyclically in verbs and adjective and post-cyclically in nouns.

In this chapter, we argue that the schwa problems cited above, and consequently CMA syllable structure can be accounted for adequately within OT as developed by Prince and Smolensky (1993) and extended in CT by McCarthy and Prince (1995, 1999). In particular, we will show that structural constraints such as the constraints requiring syllables to have onsets and no codas, and faithfulness constraints regulating the relationship between the input and the output along with other constraints, are what we need in order to account for CMA syllable structure. We will also show that it is the ranking of these constraints determines syllabic well-formedness.

The chapter is organized into two major sections. In the first section, we present a critical review of the previous accounts of MA syllable structure within a non-linear framework as proposed in Benhallam (1990a) and Al Ghadi (1990). In the second section, we argue that a constraint-based framework such as OT is far better than a rule-based one. Therein, we show, following a proposal made in Al Ghadi (1994), the mechanism CMA resorts to in order to derive the minimal prosodic word. Also in this section, the representation of geminates is raised in relation to prosodic structure. Here we argue that prosodic minimality in non-derived words containing geminates is achieved in the same way as other words which lack geminates. Furthermore, we raise the question of cyclic syllabification in verbs and point to directions on how to solve this problem. Finally we propose to reanalyze nominal schwa syllabification by making use of a set of universal constraints which show that schwa syllables prefer a coda with a high sonority. Throughout this chapter, we argue that CMA derives syllabic well-formedness from the interaction of constraints pertaining to Universal Grammar.

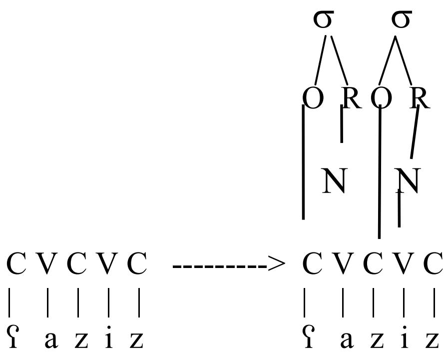
2. PREVIOUS ACCOUNT OF MOROCCAN ARABIC SYLLABLE STRUCTURE

As it has been stated above, the vowel inventory comprises the three basic vowels [i, u, a] and the epenthetic schwa [ə]. To understand the behavior of the schwa in CMA, one has to have recourse to syllable structure. One of the most elaborate and frequently cited work on MA syllable structure is that of Benhallam (1990a). Benhallam distinguishes two types of syllabification in MA: full-vowel syllabification [i, u, a], and schwa syllabification. The author proposes a Syllable Structure Assignment Algorithm (SSAA) which proceeds from right to left as follows:

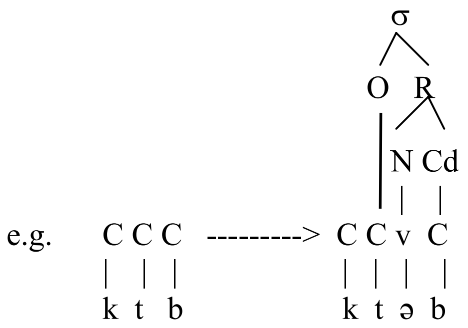
-1-

a. Onset and rime rule

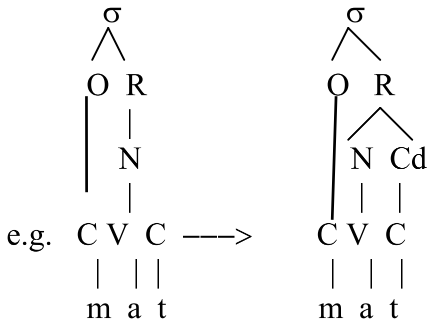
e.g.



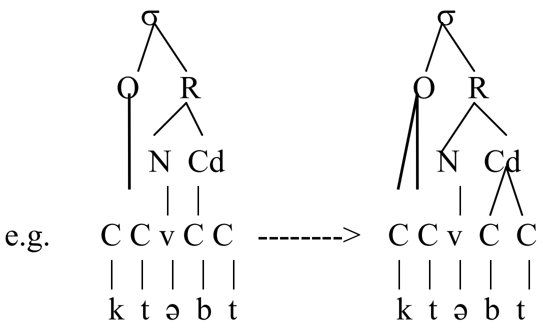
b. Assignment of a CvC syllable structure to every sequence of unsyllabified CC starting from right to left. The v is to be interpreted as a schwa [1]:



c. Assignment of a non-syllabified C to the coda position of a codaless syllable.



d. Assignment of a stray C as premargin or postmargin to a following onset or a preceding coda:



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[1] I am using v instead of Benhallam's dummy symbol ∆. The lower case v's should be distinguished from the upper case V's. The former refer to the vocalic positions that are interpreted as schwas, whereas the latter refer to the full vowels [a, u, i].

As we can see in 2 the SSAA proceeds by assigning CV core syllables (where V is one of the full vowels [i, u, a]). It is only after this stage that schwa syllables are built. What the schwa syllabification rule in 2b basically does is that it takes every unsyllabified CC sequence and assigns to it the syllabic shape CvC**.** In other words, it creates what Selkirk (1981) calls degenerate syllables whose nucleus we note as v. At a later stage, the v's are filled with schwas (Benhallam 1988, 1990a).

The SSAA accounts for a large number of items in MA. To start with consider the non-derived trisegmental verbs in 2 below.

-2-

Vb root	*Vb stem*	*Gloss*
ktb	ktəb	write
ʃTħ	ʃTəħ	dance
DRb	DRəb	hit
gls	gləs	sit down

Basically all the non-derived trisegmental sound verbs are derived in the same way. What we need are just rules 1b and 1d. The first rule creates a nucleus whose onset is the second consonant of the root and coda is the third consonant. The second rule adjoins the first consonant of the root as onset to the syllable created by the previous rule, thus creating a branching onset.

Non-derived adjectives and a large number of non-derived nouns can be obtained much in the same way as the items in 2. Consider the examples in 3 below:

-3-

a. *Adjective*s

Root	*Stem*	*Gloss*
ʕrʒ	ʕrəʒ	lame
ħwl	ħwəl	cross-eyed
kħl	kħəl	black
SfR	SfəR	yellow
byD	byəD	white

b. *Nouns*

ktf	ktəf	shoulder
ʒml	ʒməl	camel
smn	smən	preserved butter
ʒbl	ʒbəl	mountain

What the examples in 2 and 3 show is that any /CCC/ sequence is syllabified as CCəC, exactly as predicted by Benhallam's SSAA. The algorithm in 1 also accounts and in a nice fashion for non-derived quadrisegmental verbs (4a) and nouns (4b):

-4-

	Root	*Stem*	*Gloss*
a.	TRʒm	TəRʒəm	translate
	frgʕ	fərgəʕ	explode
	SRfq	SəRfəq	slap
	krkb	kərkəb	roll
b.	mslm	məsləm	Muslim
	fndq	fəndəq	hotel
	tnbr	tənbər	stamp

Given a sequence such /CCCC/, rule 1b will apply to give a disyllabic word of the type CəCCəC. However, there are items that cannot be syllabified by the SSAA. Consider some representative examples below:

-5-

a. *Verbs*

Root	*Stem*	*Gloss*
ʕDD	ʕəDD	bite
mdd	mədd	give
mss	məss	touch
ʒRR	ʒəRR	pull

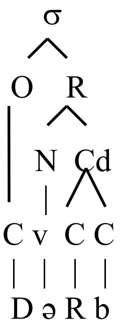
b. *Nouns*

i.	DRb	DəRb	hitting
	lʕb	ləʕb	game
	brd	bərd	cold

ii.	srʒ	sərʒ	saddle
	dnb	dənb	sin
	frx	fərx	bird

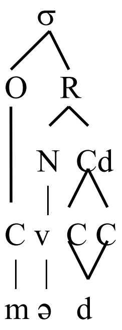
The items in 5a represent the class of geminated verbs. Those in 5b represent the class of non-derived trisegmental nouns, with the specification that the items in 5b.i have their corresponding verbs where the schwa appears in a different environment (cf. [DRəb], [lʕəb] and [brəd]). These items are counterexamples to Benhallam's algorithm since the schwa is placed between the first and second consonants and not between the second and third as predicted by 1b. To solve this paradox, Benhallam (1990a), who was very much concerned with treating all the forms uniformly regardless of their syntactic category, assumes that items having the structure CəCC as in 5b have an underlying syllabic template which distinguishes them from the other forms syllabified by the SSAA. The underlying template looks like the one in 6 below:

-6-



This template accounts not only for forms on the pattern CəCC but also for roots whose second consonant is geminated as could be seen from the structure of the verb [mədd].

-7-



Notice from the structure in 7 above that in the case of geminates, the only position of the schwa is between the first consonant and the second one (that is the geminated consonant which is [d]) and this in conformity with the OCP (McCarthy 1986) which prohibits two identical segments from occurring on the same tier. (See Benhallam 1991, and Rguibi 1990 on the OCP effect in the treatment of geminates in MA)

Furthermore, the algorithm in 1 can adequately account for affixed items such as the following:

-8-

a.	DRb-at	DəRbat	she hit
	lʕb-na	lʕəbna	we played
b.	ktb-t	ktəbt	I wrote
	ʒRʒR-u	ʒəRʒRu	they trailed

Assuming that syllabification applies after all the morphological rules have applied will yield the correct output in 8a. First core syllables are formed, giving [DR.ba.t] and [lʕb.na.] (The periods mark syllable edges). Only after that does schwa epenthesis apply to yield [DəRbat] and [lʕəbna]. The same assumption does not work for the items in 8b since a non-cyclic syllabification would give the unattested forms *[ʒRəRʒru] and *[kətbət] [2]. For Benhallam, syllabification should be allowed to apply cyclically to yield the attested output. In the items in 8b above syllabification applies as in 9 below. The brackets stand for cycles.

-9-

Input	[[ktb]t]	[[ʒRʒR]u]
	First cycle	
Syllabification	ktəb	ʒəR.ʒəR
	Second Cycle	
Affixation	ktəb.-t	ʒəR.ʒəR.-u

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[2] The form [kətbət] is attested in a number of varieties of MA but with the meaning "she wrote". Following a suggestion made to me by Selkirk (p.c.), I assume that the input of such a form is /ktb-Vt/ and that the V may be realized as either [ə] or [a], depending on the variety of MA under study.

Syllabification	ktəbt	ʒəR.ʒə.Ru
Output	[ktəbt]	[ʒəRʒRu]

Syllabification first applies to the innermost bracketed items in the first cycle. It reapplies in the second cycle after affixation to adjoin the stranded [t] as a postmargin to the preceding syllable, thus giving the correct output [ktəbt]. In the remaining item, and after the suffixation of [-u] the consonant [r] , syllabified as a coda in the first cycle, is assigned as an onset to this suffix and this follows from the fact that MA does not allow onsetless syllables. Consequently, the schwa is left in an open syllable, thus subject to deletion.

Although the SSAA seems to account for a large number of items in MA, it is questionable on theoretical and empirical grounds. First, the extrinsic ordering of some syllabification rules is established to avoid the generation of ungrammatical forms. If we order rule 1c before rule 1b, we would, for example, get the ungrammatical item *[surt] instead of the correct [surət] 'to lock'. Moreover, an input form has to go through different stages before it reaches the final stage of phonetic interpretation. (See for example the derivations in 9 above). In section 3 a constraint-based analysis is proposed within the OT framework. Instead of the step-by-step SSAA, OT accounts for schwa occurrences in terms of constraints pertaining to UG which apply in a non-serialist way.

Second, the SSAA has to have recourse to the notion of directionality and the notion of cyclicity to derive the correct output (see 9 above). The analysis proposed in this work derives directionality and cyclicity of syllabification from the interaction of constraints requiring that some edge of the output coincide with that of a prosodic category and other constraints requiring that the derived output be faithful to the base (See chapter four for details).

Third, the SSAA does not give much detail about the nature of the rules themselves and how they relate to other (similar) rules in natural languages. For example, it does not show that 1a derives from the fact that CV core syllables are basic cross-linguistically, and that such syllables have an obligatory onset. Nor does the SSAA make it clear that 1b derives from a universal constraint, namely that segments must be parsed into some syllable. Within OT, 1a and 1b derive from two different constraints: ONSET, which demands that syllables have an onset, and PARSE-seg, which demands that all segments of the input belong to a syllable. The fact that all

MA syllables must have an onset and that consonants must belong to a syllable is achieved by ranking the two constraints at the top of the ranking scale.

Fourth, the Algorithm distinguishes between two modes of syllabification: derived and underlying. Derived syllabification is accounted for by the SSAA. As to underlying syllabification, it is accounted for by the template in 6 and is needed especially for items having the pattern CəCC which do not abide by the SSAA. Some of these items are given in 10a. The items in 10b and 10c are intended for comparison; further examples are given in section 3.6 below:

-10-

a.	dənb	sin
	DəRb	hitting
	bənt	girl
b.	rʒəl	leg
	qfəz	cage
	ʕsəl	honey
c.	smən	preserved butter
	nməl	ants
	gməl	lice

According to Benhallam (1990a), the schwas in 10b and 10c are regular because they meet the environment predicted by the SSAA. Contrariwise, the schwas in 10a are exceptions and therefore should have an underlying syllable template like the one in 6 above. This means that nouns on the pattern CəCC and CCəC belong to different classes, something which cannot be justified on independent grounds. (See Al Ghadi 1990 for the arguments presented in favor of considering the two patterns to belong to the same class, namely that of non-derived trisegmental nouns).

To account for items like the ones in 10, Hammoumi (1988) proposes that the placement of the schwa is determined by the degree of dissimilarity between the sonority of the second and third consonants in a non-derived trisegmental noun or adjective. However, and as it has been pointed out only nouns abide by the sonority constraints, whereas adjectives and verbs do not and as such we are forced to abandon Hammoumi's assumption in search of a more elaborate analysis of the cases in 10.

A better solution is proposed by Al Ghadi (1990) who maintains that schwa epenthesis in items such as those in 10a and consequently nominal schwa syllabification is to a large extent dependent on the sonority of the consonants occupying the second and third positions in trisegmental nouns. According to the author the schwa is epenthesized before the most sonorous consonant. If the consonants in question have the same sonority[3], the schwa is epenthesized before the third consonant. Al Ghadi's findings are reproduced below, where |C| stands for the relative sonority of C.

-11-

In nonderived trisegmental nouns, a schwa is epenthesized in the following environments

a. $C_1əC_2C_3$, if $|C_2| > |C_3|$, e.g. 10.a.

b. $C_1C_2əC_3$, if $|C_3| > |C_2|$, e.g. 10.b

c. $C_1C_2əC_3$, if $|C_2| = |C_3|$, e.g. 10.c

It should be noted that there are some exceptional nouns that do not conform to the sonority hierarchy (see Benhallam 1980, for a list of these items). Examples of such nouns include items like [ʕməʃ] "sleep", [ħəbs] "jail", [ħməd] "Ahmed (proper noun)"and [ħnəʃ] "snake". Surprisingly enough, these items include a pharyngeal as one of their elements. All in all, we believe, following Al Ghadi (1990), that a large number of nouns abide by the sonority principle.

Relative sonority derives from the universal theory of syllable structure. That the schwa is epenthesized before the most sonorous consonant in a CCC sequence is not specific to MA but it is found cross-linguistically, something that 11 above cannot predict.

OT offers a way to account for the regular cases of schwa epenthesis, that is cases which can be handled by the SSAA in 1 by having recourse to universal constraints instead of language-particular rules. It also offers a straightforward analysis for the exceptional items on the pattern

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[3] Al Ghadi (1990) assumes that the nasals and the liquids have the same sonority and that the class of glides comprises, in addition to [w] and [y], the pharyngeals [ħ] and [ʕ].

CəCC to the effect that they are subject to a universal constraint, namely the Sonority Hierarchy Constraint. (See section 3.6 for details)

To sum up, it has been pointed out that an OT approach, based on universal constraints such as the one requiring that segments be grouped into syllables and that these syllables have onsets obviates the need for a rule-based algorithm of syllabification. An OT approach has an explanatory power since it derives syllabic well-formedness from constraints pertaining to UG.

3. CASABLANCA MOROCCAN ARABIC SYLLABLE STRUCTURE AND OPTIMALITY THEORY

In this section we show how OT offers a better analysis of CMA syllabification based on constraints that pertain to UG. More specifically, we intend to show that the structural constraints ONSET and NO-CODA and the faithfulness constraints PARSE and FILL (revised by McCarthy and Prince 1995) along with other constraints on sonority and directionality of syllabification will allow us to capture significant generalizations about CMA syllable structure.

The following assumptions are maintained from previous analyses of MA syllable structure:

(i) All cases of schwa in MA are epenthetic (Benhallam 1980, 1988, 1990a).

(ii) MA distinguishes between full vowel syllabification, which has the effect of forming CV syllables; and schwa syllabification, which assigns to a non-syllabified CC sequence the shape CəC in accordance with Benhallam's (1990a) SSAA.

(iii) MA distinguishes between two modes of schwa syllabification: nominal schwa syllabification and verb and adjective schwa syllabification. Nominal schwa syllabification is argued to be dependent to a large extent on the sonority of the surrounding consonants (Al Ghadi 1990, Boudlal 1993, to appear a) while verb and adjective schwa syllabification is governed by Benhallam's SSAA [4].

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[4] That a language has two modes of syllabification is not unnatural. The way phonological rules apply to verbs and nouns need not be the same. For example, Bobaljik (1997) notes that in Itelmen, a language spoken in the Northwest coast of the Kamchatka peninsula of Russia, the rule which epenthesizes a schwa applies cyclically in the verbal system but non-cyclically in the nominal system. Also, Smith (1997) proposes domain specific constraints for the lexical category "noun", which need not apply to other categories.

These assumptions have been reformulated in terms of constraints on syllabic well-formedness to fit in the theoretical framework adopted. (See subsections 3.2-3.6 below for more detail)

In the following subsection we present the basic tenets of syllable theory in OT as outlined in Prince and Smolensky (1993) and elaborated in McCarthy and prince (1994a, 1994b, 1995, 1999).

3.1 Syllable Sructure in Optimality Theory

According to Prince and Smolensky (1993) syllable structure in OT is generated in the same way as any other grammatical property. The function Gen produces a set of candidates for any unsyllabified input. The function Eval chooses the optimal candidate which should abide by the constraints imposed by UG and ranked on a language-particular basis.

It is a widely held view that the basic syllable structure is of the type CV (Jakobson (1962), Clements and Keyser (1983), among others). Two basic universal constraints emerge from the above statement. Prince and Smolensky (1993: 85) state them as follows:

-12-

a. ONSET

Syllables must have an onset.

b. NO-CODA

Syllables must not have a coda.

Together ONSET and NO-CODA describe what is referred to as the universally unmarked characteristic of the structures involved. Given an input with the shape /CVCV/, the function Gen may supply the following candidates, among others:

-13-

a. CV. CV

b. CVC.V

Of the two parses, 13a is the optimal one since it satisfies the two constraints stated in 12. The parse in 13b is suboptimal in two ways: the first syllable is closed and as such violates the NO-CODA constraint; the second syllable violates the ONSET constraint.

Besides the ONSET and the NO-CODA constraints, Prince and Smolensky (1993) claim that there is a second group of constraints on syllable structure, stated as follows:

-14-

a. PARSE

Underlying segments must be parsed into syllable structure.

b. FILL

Syllable positions must be filled with underlying segments.

Together PARSE and FILL constitute what is referred to as the "faithfulness family of constraints". They constrain the relation between structure and input. They also demand that well-formed syllable structures are those in which input segments match the syllable positions in a one-to-one fashion.

Later developments within the OT framework have given rise to CT (McCarthy and Prince 1995, 1999) which extends the reduplicative copying relation of McCarthy and Prince (1993a) to other domains where identity relations are imposed on pairs of related representations such as input and output (and output and output in the extended version of CT (McCarthy, 1995, 1997, Benua 1995, 1997, Kenstowicz 1996, 1997, Kager 1996, Burzio 1996, Basri et al 1998, Selkirk 1999). McCarthy and Prince (1995) reformulate Prince and Smolensky's (1993) faithfulness constraints in such a way as to liberate them from their connection with syllabification and phonetic interpretation. They instead propose that the constraint FILL and part of what the constraint PARSE does be replaced by DEP and MAX, respectively. The domain-specific instantiations of MAX and DEP we will be using are mainly the ones that hold between the input and the output. Under CT, the two constraints are formulated as follows:

-15-

a. MAX-IO

Every segment of the input has a correspondent in the output.

b. DEP-IO

Every segment of the output has a correspondent in the input.

To see how MAX and DEP work, consider an input of the shape /CVC/. The function Gen may supply the candidates in 16. The lower case v stands for an epenthetic vowel:

-16-

a. CVC
b. CV
c. CV.Cv

In 16a, the whole input is parsed as one syllable, thus violating the NO-CODA constraint. In 16b only the sequence CV is syllabified, satisfying the NO-CODA and at the same time violating MAX-IO since the final consonant has been deleted. The sequence in 16c has resorted to final v addition and as such satisfies both the NO-CODA and MAX-IO but violates DEP-IO which demands that the segments of the output have correspondents in the input.

The optimal candidate cannot be determined from the structures in 16 above because each of these structures violates one constraint. For Prince and Smolensky (1993), the optimal forms are those that display minimal violation of universal constraints. Given the facts in 16, it follows that the optimal candidate can only be determined after the ranking of these constraints. The candidate that violates the higher-ranked constraints is suboptimal while the one that violates the lower-ranked constraints is optimal. It should be noted here that individual grammars rank universal constraints differently depending on the internal system of the language concerned. In a language that allows codas, the optimal candidate would be 16a and as such the NO-CODA constraint would be ranked low in the ranking scale. In a language where MAX-IO is ranked low, the structure in 16b would be the optimal one. Finally, in a language where DEP-IO is ranked low, the structure in 16c would be the optimal one.

To sum up, the constraints on syllable structure are of two types: the ONSET and NO-CODA constraints, and the revised faithfulness constraints which comprise MAX-IO and DEP-IO. In section 3.2 below, we turn to see how the ranking of MAX-IO and DEP-IO and their interaction with other constraints can account for CMA syllable structure.

3.2 Universal Constraints on CMA Syllable Structure

As stated in section 3.1 syllable structure in OT is generated in the same way as any grammatical structure. The function Gen supplies a large number of candidate parses; Eval chooses the optimal parse according to the constraint hierarchy. It has also been pointed out above that in order to account for syllable structure in CMA, we need universal constraints like ONSET, NO-CODA, DEP-IO and MAX-IO.

In this section, we consider first the interaction of ONSET and DEP-IO. It is an established fact in MA that a syllable (whether it is at the beginning or within the prosodic word) cannot start with a vowel. Whenever such a situation arises, recourse is made to epenthesis. Consider the following items for illustration:

-17-

a.	ʔatay	tea	ʃrib-atay	drinking tea
	ʔargan	Argan (tree)	zit-argan	Argan oil
	ʔana	I	bɣit-ana	I want
	ʔax^{w}ər	Another	waħd-ax^{w}ər	Another one
b.	slawi	from Salé	sla	Salé (a city)
	smawi	sky-blue	sma	sky
	DRawi	from the Plain Dra	DRa	The Plain Dra
	tadlawi	from the Plain Tadla	tadla	The Plain Tadla

In 17a the epenthetic element is the glottal stop; in 17b, it is the glide [w] which is epenthesized between the suffix [i] and the stem final vowel. Both cases involve epenthesis and therefore violation of DEP-IO. Consider the tableau below for illustration:

It is evident from the items in 17 that any form violating ONSET will be eliminated since there are candidate parses that meet the constraint ONSET by epenthesizing a glottal stop or a glide, thus forcing violation of DEP-IO. The behavior of the items in 17 points to the fact that ONSET must be ranked above DEP-IO, that is ONSET must dominate DEP-IO. This domination is shown in the following tableau for the input /atay/:

-18-

/atay/	ONSET	DEP-IO
a. a.tay	*!	
☞b. ʔa.tay		*

If we reverse the ranking of ONSET and DEP-IO, the optimal candidate will be an item with an onsetless syllable *[atay], a form CMA rules out.

To see if MAX-IO interacts with ONSET and DEP-IO, we add another candidate to the ones in 18b above. The candidates we will examine are given below. The symbol 💣 shows the wrong optimal candidate according to the constraint ranking given:

-19-

/atay/	DEP-IO	MAX-IO
a. ʔa.tay	*!	
💣 b. tay		*

It is to be noted here that Gen allows for the generation of candidates like the one in 19b, where a segment is deleted. The deletion in 19 leads to the satisfaction of ONSET and forces violation of MAX-IO. The domination relation established in 19 makes the wrong prediction since it posits as the optimal parse the one where the vowel [a] of the input is deleted. This means that the two constraints should not be ranked with respect to each other as in 20 below:

-20-

/atay/	MAX-IO	DEP-IO
☞a. ʔa.tay		*
b. tay	*!	

The constraint tableau in 21 shows the interaction of ONSET, MAX-IO and DEP-IO. The dotted line shows that ONSET and MAX-IO are not ranked with respect to each other:

-21-

/atay/	ONSET	MAX-IO	DEP-IO
☞ a. ʔa.tay			*
b. tay		*!	
c. a.tay	*!		

As seen in 21, each of the candidates incurs one violation mark; but since violation of lower-ranked constraints (DEP-IO) is allowed to secure higher-ranked constraints (MAX-IO and ONSET), it follows that the optimal candidate is [ʔatay].

The constraints above could also account for the cases where a glide is epenthesized instead of the glottal stop. In the constraint tableau below we consider three candidate parses for the input /tadla-i/:

-22-

/tadla-i/	ONSET	MAX-IO	DEP-IO
☞ a. tad.la.wi			*
b. tad.li		*!	
c. tad.la.i	*!		

The tableaux considered so far show that any form violating ONSET and MAX-IO will never be optimal.

Having considered the interaction of the constraints in MAX-IO, ONSET and DEP-IO, let us now examine the faithfulness constraints DEP-IO and MAX-IO and their interaction with the NO-CODA constraint. Consider the parsed items below for illustration:

-23-

ʃaw.ya	*ʃa.wə.ya	roasting (fem.)
ʕay.ʃa	*ʕa.yə.ʃa	alive (fem.)
mat	*ma.tə	he died
sa.lat	*sa.la.tə	she finished

The items above show that it is more optimal to have codas than gratuitously violate DEP-IO. They further show that NO-CODA must be ranked low in the scale, lower than DEP-IO as the tableau in 24 below shows. Given the fact that MAX-IO dominates DEP-IO, it follows from this that MAX-IO also dominates NO-CODA, by transitivity:

-24-

/ʃawya/	MAX-IO	DEP-IO	NO-CODA
☞a. ʃaw.ya			*
b. ʃa.ya	*!		
c. ʃa.wə.ya		*!	

The candidate in 24b has resorted to schwa epenthesis to avoid violation of the NO-CODA constraint, thus resulting in a form that surfaces with a schwa in an open syllable. To block such forms I have proposed a constraint dubbed *ə]$_{\sigma}$ which has the effect of ruling out open schwa syllables. The effect of this constraint could be seen in forms inflected for the feminine and to which the object clitic [-u] is added. If the feminine suffix is [at] (as is the case with CMA), nothing special happens; the constraint ONSET is satisfied by adjoining the [t] to constitute the onset of a syllable whose nucleus is the object clitic. If, on the other hand, the feminine suffix is [ət], another variant found in other varieties of MA, the final [t] gets geminated. The initial part of the geminate functions as a coda, thus observing the constraint *ə]$_{\sigma}$, whereas the second part functions as an onset to the final syllable.

-25-

DəRbatu	DəRbəttu	she hit it/him
kətbatu	kətbəttu	she wrote it
sərqatu	sərqəttu	she stole it
qətlatu	qətləttu	she killed it/him

It will be seen that the effect of the constraint $*ə]_\sigma$ could be obtained from the NO-CODA constraint. That the schwa does not occur in open syllables follows from ranking NO-CODA low in the ranking scale and not from the constraint $*ə]_\sigma$ itself.[5]

The next cases that will be considered are cases of items that involve schwa epenthesis. Consider the examples in 26 below for illustration.

-26-

a.	xədma	job
	SəmTa	belt
	DəRba	a hit
	zəbda	butter
b.	DaRəb	hitting
	ʃarəb	drinking
	katəb	writing
	sakət	mute

The schwa in the above items is not part of the underlying representation; it is epenthetic (Benhallam, 1980, 1988, 1990a). In CT terms, epenthesis means violation of DEP-IO. In the items above, we allow for the violation of DEP-IO to secure a higher-ranked constraint, namely ONSET. A reasonable question that should be asked here is the following: What is it that forces violation of DEP-IO in the items in 26?

As we have shown above, the first step in Benhallam's (1990a) SSAA is to build core CV syllables. Thus items such as those in 26a are syllabified as CC.CV. (cf. Sm.ta.) whereas items such as those in 26b are syllabified as .CV.CC (cf. .ka.tb). Later syllabification rules assign the first or final two unsyllabified consonants to a syllable whose nucleus is the schwa.

Within the theoretical framework adopted here, we assume that schwa epenthesis and consequently DEP-IO violation is triggered by some dominating constraint labeled PARSE-seg and which Prince and Smolensky (1993) state as follows:

-27-

PARSE-segment (henceforth PARSE-seg)

Every segment must belong to a syllable.

---

[5] Thanks to Lisa Selkirk, Karim Bensoukas and Paul de Lacy for pointing out this to me.

We assume that the constraint PARSE-seg is also undominated since all the segments of an input are parsed into some higher prosodic constituent, namely the syllable. Given the fact that all the segments in the input must be realized in the output by virtue of undominated MAX-IO, the only way to syllabify the two stray consonants in 26 is by epenthesizing a schwa. Consider the different parses of the word [katəb] from the input /katb/. We assume that both MAX-IO and PARSE-seg dominate DEP-IO [5].

-28-

/katb/	MAX-IO	PARSE-seg	DEP-IO
☞a. ka.təb			*
b. .ka.tb		**!	
c. ka	**!		
d. ka.tə.bə			**!

The optimal candidate satisfies both MAX-IO and PARSE-seg but violates DEP-IO, a lower-ranked constraint. The output in 28b is suboptimal because two of its segments (i.e. [t] and [b]) do not belong to a prosodic constituent, thus violating PARSE-seg. Even if we assume that the sequence tb were in fact a syllable, we would have to assign the consonant [b] as a nucleus to that syllable whose onset is [t], something that CMA does not resort to as will be argued below. The parse in 28c is discarded because two of its input segments were deleted. Finally the parse in 28d is bad because it incurs two violation marks of DEP-IO.

What the tableau above does not include is the monosyllabic candidate [katb] which does not violate any of the constraints in 28 and should therefore win over the real optimal candidate [katəb], which violates DEP-IO. In order to rule out candidates such as [katb], we need to invoke the constraint *COMPLEX-MARGIN (Prince and Smolensky 1993). The constraint is stated as follows:

---

[5] One might wonder whether we really need the constraint PARSE-seg since MAX-IO ensures that all the segments in the input appear in the output. PARSE-seg triggers schwa epenthesis in words whose input consists exclusively of consonants such as [ktəb]. An alternative constraint to PARSE-seg would be NUCLEUS, which Prince and Smolensky (1993) assume to be universally undominated. However, the problem with NUCLEUS is that it cannot force epenthesis in an input such as /CCC/. All it says is that if there are syllables, they have to have nuclei. Since there are no syllables in /CCC/, it follows that NUCLEUS cannot trigger schwa epenthesis.

-29-

*COMPLEX-MARGIN (henceforth *COMPLEX)

Codas and onsets must not branch.

The constraint, if ranked above DEP-IO, would rule out forms such as [katb] with a complex coda as the tableau below shows:

-30-

/katb/	*COMPLEX	DEP-IO
☞a. ka.təb		*
b. katb	*!	

We assume that MAX-IO, PARSE-seg and *COMPLEX are not ranked with respect to each other and that the three of them must dominate DEP-IO. This means that these three undominated constraints are what triggers schwa epenthesis and therefore DEP-IO violation.

The constraints seen so far are of two types: (a) the undominated constraints, which are ONSET and MAX-IO, PARSE-seg and *COMPLEX; and (b) the dominated ones which are DEP-IO and NO-CODA.

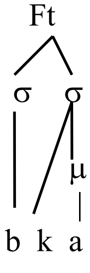
Next, we consider items that begin with a cluster of consonants, which present a special case that needs to be analyzed. An input such as /bka/ could have one of the following output candidates.

-31-

	PARSE-seg	MAX-IO	*COMPLEX	DEP-IO
a. bka			*!	
💣b. bə.ka				*
c. ka		*!		

The constraints in 31 wrongly predict that the optimal candidate is 31b, i.e. the candidate that has epenthesized a schwa to satisfy *COMPLEX. What facts about CMA point out to is that the optimal form must be a form that preserves all of the input segments and does not incur a DEP-IO violation. Such is the case with the candidate [bka], except that this form violates *COMPLEX by allowing a complex onset in the output. Since deleting one of the two consonants will result in violation of undominated MAX-IO in CMA (and in other Arabic dialects, Abu Mansour 1995), it follows that the margin consonant [b] must be assigned as extrasyllabic in the sense of Ito (1986, 1989) and McCarty and Prince (1988). The notion of extrasyllabicity was first suggested for MA in Al Ghadi (1990) and adopted in subsequent work such as Rguibi 1990, El Himer 1991, Imouzaz 1991, and Boudlal 1993, among others. In all these works, extrasyllabicity is shown to operate at the edges of the word. In OT terms, extrasyllabicity has been regarded as a lack of parsing and therefore violation of MAX-IO. However and as we have seen above, the constraint MAX-IO is undominated in CMA, ensuring that all the segments in the input appear in the output. Given a situation where an initial cluster of consonants needs to be syllabified, the only way to do it is by assigning the first member of the cluster to a degenerate syllable (Selkirk 1981) and the second member as an onset to the main syllable. Thus the verb like [bka] “he cried” may be represented as in 32 below:

-32-



It should be noted that adjoining the consonant [b] to the syllable node does not constitute a violation of PARSE-seg. In fact what is violated is Selkirk’s (1980) Strict Layer Hypothesis (STRICT-LAYER) which demands that every prosodic constituent be dominated by a constituent of the immediately superordinate type, that is the mora is dominated by the syllable, and the syllable is dominated by the foot which is, in turn, dominated by the prosodic word.

The representation in 32 above shows that a distinction should be made between two types of syllables: a degenerate syllable, which will be referred to as minor syllable, and a major syllable. A minor syllable consists solely of a consonant, whereas a major syllable is one whose nucleus is a schwa or one of the full vowels [i, u, a]. Since having a major syllable is better than having a minor one, the grammar of CMA will have to incorporate a constraint against minor syllables. This constraint is stated as follows:

-33-

*MINOR SYLLABLE (henceforth *Min-σ)

Minor syllables are prohibited.

This constraint will have to be dominated by DEP-IO so as to prevent epenthesis in cases such as [bka]. In 34, we show how the output [b.ka] is obtained:

-34-

	*COMPLEX	DEP-IO	*Min-σ
☞a. b.ka			*
b. bka	*!		
c. bə.ka		*!	

The structure in 32 satisfies *COMPLEX by assigning the first consonant of the optimal candidate as a minor syllable but raises another issue related to word minimality. According to Prince and Smolensky (1993), any member of the morphological category corresponds to a prosodic word (LX ≈ PWd), which in turn corresponds to a foot. According to the authors, the foot is subject to binarity which requires the PWd to have at least two moras if the language under study is quantity-sensitive or two syllables if the language is quantity-insensitive. The constraint FOOT-BINARITY is stated as follows:

-35-

FOOT-BINARITY (henceforth FT-BIN)

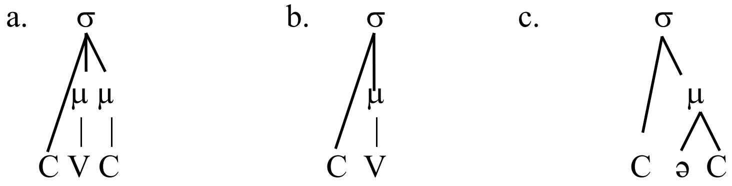
Feet are binary under syllabic or moraic analysis.

The word [bka], the way it is represented in 32, violates FT-BIN although it is a lexical word. In the next section, we turn to examine the nature of the prosodic word and the mechanisms CMA resorts to in order to satisfy FT-BIN.

3.3 The Prosodic Word in CMA

Under moraic theory (Hyman 1985, Zec 1988, Hayes 1989 and others), CMA distinguishes between bimoraic CVC heavy syllables, where V is different from the schwa (36a); and monomoraic light syllables, which, in turn fall into two types: one where the mora dominates one segment (36b); the other where the mora dominates the schwa and another consonant (36c):

-36-



There is yet another light syllable that is referred to as minor and whose status will be determined down in this section.

The representation in 36c emanates from a proposal made in Jebbour (1996) and adopted for Tashlhit Berber in Bensoukas (1994). These works assume that a closed syllable whose nucleus is a consonant should be monomoraic. For the purpose of the present work, we assume that the schwa in CMA is moraless and that it acquires a moraic structure only in combination with a following consonant belonging to the same syllable. Along the same lines, Al Ghadi (1994:5) assumes the moraic representations in 36, and this has led him to posit the following equivalencies between syllables whose nucleus is a full vowel and syllables whose nucleus is a schwa:

-37-

a. CV = CəC

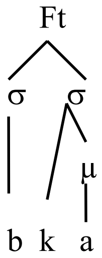
b. CVC = CəCC

c. CVCV = CəCCəC

d. CCV = CCəC

Excluding the patterns in 37a which are not considered to be lexical words[7], the patterns in 37b and 37c occur as separate lexical words in CMA and therefore satisfy both the constraints LX ≈ PWd and FT-BIN by virtue of the fact that they are both bimoraic. The patterns in 42d are monomoraic and therefore constitute a clear violation of FT-BIN. Notice that these patterns start with a consonant cluster(CCV and CCəC). In section 3.2 we have posited the constraint *COMPLEX which demands that syllable margins consist of only a single consonant. We have shown that whenever there is a consonant cluster, one of the two members is assigned as an onset or coda, depending on the position in the syllable, while the other member constitutes a minor syllable on its own. To make things clearer, consider the structure of the verb [bka] in 32 above which repeat in 38 below.

-38-



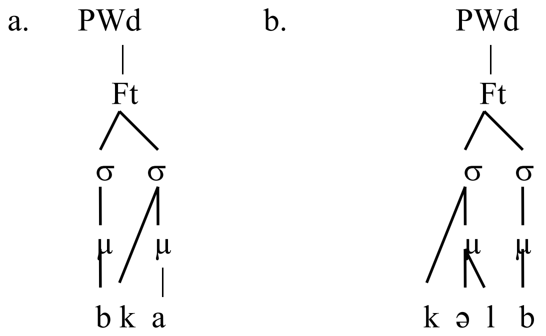
The structure in 38 shows that the lexical word [bka] does not meet the requirement of a PWd. In other words, it does not satisfy FT-BIN, a universal constraint observed cross-linguistically. Given the state of affairs in 38, how is it possible to satisfy FT-BIN? In McCarthy and Prince (1995), for example, it has been shown that languages resort to augmentation to satisfy this constraint. Such is also the case for a very limited number of CMA words on the pattern CV (cf. see footnote 7). One way of augmenting words on the pattern CCV or CCəC is by epenthesizing a schwa between the cluster of consonants, thus resulting in the disyllabic patterns Cə.CV and Cə.CəC, which satisfy FT-BIN. However this solution is undesirable since it results in forms which are judged to be ill-formed (cf. *[bəka] and *[kətəb], for example which incur a fatal violation of DEP-IO). The second solution, which is adopted in the present work, is proposed by

---

[7] Only two words in MA have the form CV: [ʒa] "he came" and [ma] "water", and these, Al Ghadi (1994) argues, show augmentation when undergoing certain morphological processes: [ʔaʒi]/[ʒay] "come/coming" and [mihan]/[myah]/[miman] "waters".

Al Ghadi (1994:5) who considers the first member of an initial consonant cluster or the second member of a final consonant cluster as part of a degenerate syllable, where the consonant is dominated by a mora. He also proposes that this mora be adjoined directly to the foot instead of projecting its own syllable, and this under some *STRUCTURE constraint which favors a representation with less prosodic nodes and association lines. In the present work, we continue to assume the Strict Layer Hypothesis to be able to encode the notions major and minor syllables. Within Al Ghadi's model, the words [bka] "he cried" and [kəlb] "dog" will have the structures in 39.

-39-

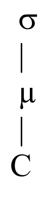


For simplification, moraic structure will be given only when it bears on the argument. Thus, when moraic representation is relevant, structures such as those in 39a and 39b will be rewritten as [b$^{\mu}$.ka$^{\mu}$] and [kəl$^{\mu}$.b$^{\mu}$], respectively; otherwise, they are written as [b.ka] and [kəl.b]. In both cases the moraic consonant belongs to a minor syllable rather than to a major one.

The moraification of a consonant dominating a minor syllable leads to the recognition of another type of light syllable in addition to CV and CəC. This syllable is represented as follows:

-40-

The minor syllable in CMA



Notice that the moraification of consonants is the result of the requirement that feet be binary. Thus in a form such as [$b^{\mu}.ka^{\mu}$], satisfying the constraint FT-BIN forces the consonant [b] to be moraic, thus violating a constraint Prince and Smolensky (1993) call Nuclear Harmony and which we give in 41:

-41-

Nuclear Harmony (henceforth H-NUC)

A higher sonority nucleus is more harmonic than one with lower sonority.

H-NUC considers C-nuclei to be less harmonic than V-nuclei. However, with words on the pattern CCV and CCəC, the only way to satisfy FT-BIN is by assigning a mora to the first consonant, thus violating H-NUC and subsequently *Min-σ. This points out to the fact that FT-BIN must outrank H-NUC and *Min-σ. We assume that *Min-σ and H-NUC are not ranked with respect to each other:

-42-

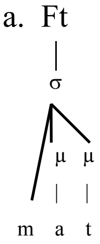
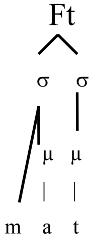
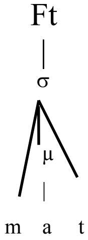
/bka/	FT-BIN	*Min-σ	H-NUC
☞a. $b^{\mu}.ka^{\mu}$		*	*
b. $b.ka^{\mu}$	*!	*	

Contrary to Al Ghadi (1994) who assumes that words on the pattern CCV are derivable from either the universal constraint FT-BIN or the constraint *COMPLEX, we maintain that the two constraints, although not rankable with respect to each other, must be kept separate and that any account of CMA non-derived trisegmental words which start or end up in a consonant cluster should make use of both of them . What *COMPLEX basically does is force a member of a consonant cluster to form a minor syllable without ever assigning a mora to it. FT-BIN, on the other hand forces a member of a consonant cluster to be moraic.

The behavior of initial and final consonant clusters in non-derived trisegmental words points out to the fact the only way to satisfy the constraint FT-BIN is by assigning a moraic status to a member of the cluster, an assumption maintained throughout this work. Therefore and in order not to be repetitive, we will be using only the constraint *Min-σ. Any form that incurs a violation of *Min-σ automatically violates H-NUC.

It should be noted that *Min-σ must outrank NO-CODA so that the final consonant of words such as [mat] "he died" would not be dominated by a mora which is dominated by a minor syllable. Consider the constraint tableau in 43 for illustration:

-43-

/mat/	FT-BIN	*Min-σ	NO-CODA
☞ a. 			*
b. 		*!	
c. 	*!		

In summary, the constraints at our disposal up to now are ranked below:

-44-

a. ONSET MAX-IO>>DEP-IO
b. MAX-IO, PARSE-seg>>DEP-IO>>NO-CODA
c. MAX-IO, PARSE-seg, *COMPLEX, >>DEP-IO>>*Min-σ, H-NUC
d. FT-BIN , *COMPLEX>> DEP-IO>>*Min-σ, H-NUC>>NO-CODA

Next, we consider non-derived items whose input is composed solely of consonants. Recall that the general rule for verbs (and adjectives) is for the schwa to be epenthesized between the second and third consonants of the root. Thus, given an input like /ktb/, Gen may provide the following candidates:

-45-

a. kətb
b. ktəb
c. ktb
d. kə.təb
e. kə.tə.bə

The constraints developed so far will give the result in 46.

-46-

	*COMPLEX	DEP-IO	*Min-σ	NO-CODA
☞b. k$^{\mu}$.təb$^{\mu}$		*	*	*
☜a. kət$^{\mu}$.b$^{\mu}$		*	*	*
c. ktəb$^{\mu}$	*!			*
d. kə$^{\mu}$.təb$^{\mu}$		**!		*
e. kə$^{\mu}$.tə$^{\mu}$.bə$^{\mu}$		***!		

The tableau shows that candidate 46c is ruled out because it violates *COMPLEX by allowing a complex onset. It also shows that candidates 46d and 46e are excluded because they incur too many violations of DEP-IO. We are left with candidates 46a and 46b which tie in all the constraints. If this is so, how is it possible to distinguish between [k.təb] where the schwa is placed between the second and the third consonants of the root and [kət.b] where the schwa is placed between the first and second consonants of the root?

To answer this question, it should be noted that the difference between the two forms reflects the directionality of syllabification. Right-to-left syllabification gives the form [ktəb]; left-to-right gives the form [kətb]. As it has already been pointed out, CMA schwa syllabification proceeds from right-to-left and assigns every unsyllabified CC sequence the shape CəC. The question that should be asked at this stage is the following: how is it possible to capture the sense of directionality within a constraint-based framework?

To account for directional syllabification in CMA, we make use of McCarthy and Prince's (1993b) Generalized Alignment, and more particularly the constraint ALIGN (stem, R, σ, R) which has the effect of preventing epenthesis at the right edge of the root and ensuring that it is flush against the right edge of the syllable:

-47-

ALIGN (stem, R, σ, R) (henceforth ALIGN-R)

The right edge of the root must be aligned with the right edge of the syllable.

To account for the difference between [k.təb] and [kət.b], we assume that no domination relationship exists between *COMPLEX and ALIGN-R and that both constraints must dominate DEP-IO as the constraint tableau below
shows [6]:

-48-

/ktb/	*COMPLEX	ALIGN-R	DEP-IO	*Min-σ
☞ a. k$^{\mu}$.təb$^{\mu}$			*	*
☜b. kət$^{\mu}$.b$^{\mu}$			*	*

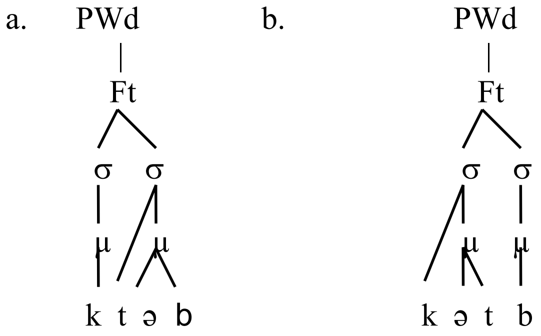
The two candidates tie once again in everything. They both satisfy ALIGN-R the way it is formulated in 47: 48a satisfies ALIGN-R by virtue of the fact that the right edge of the stem corresponds to the right edge of the syllable; 48b satisfies ALIGN-R although the right edge of the stem corresponds to a minor syllable. How is it possible then to exclude the candidate in 48b while at the same time establishing the candidate in 48a as the optimal one?

To answer this question, consider the structures in 49 below for both [k.təb] and [kət.b]:

---

[6] ALIGN-R must dominate DEP-IO not only to account for the difference between [ktəb] and [kətb] but also to prevent schwa epenthesis in stem-final position in forms such as [kətəbə] or [kətbə] for example.

-49-



Both structures contain a major syllable and a minor one. In 49a the minor syllable is at the left edge of the major syllable; in 49b it is at its right. One way to get the optimal candidate in 49a is by positing an alignment constraint, requiring that the right edge of the stem be aligned with a major syllable (Maj-σ) as stated in 50:

-50-

ALIGN-R Maj-σ

The right edge of the stem aligns with the right edge of a major syllable.

This constraint will have to dominate the general version of ALIGN-R, an example where the specific constraint dominates the general one (Beckman 1998). Thus [kət.b] is ruled out on the ground that the right edge of the stem does not align with a major syllable.

However, the problem with this constraint is that it seems to weaken the Alignment Theory by allowing it to look at the internal structure of the prosodic entity being aligned, i.e. it has to see whether it is a major or a minor syllable. For this reason, we are led to abandon the constraint ALIGN-R-Maj-σ in search for another constraint that has an explanatory power.

In order to distinguish [k.təb] from [kət.b], I assume, following a suggestion made to me by Selkirk (p.c.), that epenthesizing a schwa before the third consonant of the root instead of the second follows from the general requirement that the stem be iambic, a fact which is justified in the stress system of the language (see chapter three below). Within the Alignment Theory, iambicity could be expressed by positing a constraint requiring that the right edge of the stem be aligned with the right edge of a prominent syllable in a foot. The notation σ′ refers to the prominent syllable:

-51-

ALIGN-R (Stem, σ′) (ALIGN-R-σ′)

> The right edge of the stem must be aligned with the right edge of the prominent syllable.

The constraint is observed in a large number of items, all of which are non-derived trisegmental adjectives and verbs (except verbs with final geminates) and a class of nouns as the examples below show:

-52-

a. Verbs

Root	*stem*	*Gloss*
ktb	ktəb	write
DRb	DRəb	hit
gls	gləs	sit down

b. Adjectives

ħwl	ħwəl	cross-eyed
kħl	kħəl	black
SfR	SfəR	yellow

c. Nouns

ktf	ktəf	shoulder
ʒml	ʒməl	camel
smn	smən	preserved butter
sdr	sdər	chest

Assuming that the language does not allow complex margins ensures that the trisegmental items in 52 are syllabified as C.CəC with the first consonant being dominated by a minor syllable. Such a form satisfies ALIGN-σ′-R by virtue of the fact that the right edge of the stem coincides with the right edge of the prominent syllable of the foot, i.e. the syllable which is susceptible to bear the main-stress of the word. Such a function could be attributed only to a major syllable, i.e. a syllable whose nucleus is one of the vowels [i, u, a, ə]. A minor syllable such as the one in 40 above, which is dominated by a consonantal mora, can never be the prominent syllable. The constraint ensuring the non-prominence of a minor syllable is given below:

-53-

*Min-σ′

Prominent minor syllables are prohibited.

We assume that 53 is undominated and that it dominates ALIGN-R-σ′ as shown in the constraint tableau in 54 below. Prominence is shown by an accent (′) over a vowel if the syllable in question is a major syllable, and after a consonant if the syllable in question is a minor syllable.

-54-

/ktb/	*Min-σ′	ALIGN-R-σ′	DEP-IO
☞a. k.tə́b			*
b. kə́t.b		*!	*
c. kət.b́	*!		*

Epenthesizing a schwa before the second consonant of the stem leads to a flagrant violation of ALIGN-R-σ′. The form in 54c tries to satisfy ALIGN-R-σ′ by assigning prominence to a minor syllable thus resulting in a fatal violation of *Min-σ. Thus the optimal candidate is the one that satisfies both ALIGN-R-σ′ and *Min-σ′ by right-aligning a major syllable.

However, other items seem to argue against stem-prominent syllable right-alignment. Such is the case with verbs with final geminates and a class of nouns as shown in the data below:

-55-

a. Verbs

Root	*Stem*	*Gloss*
ʕDD	ʕəDD	bite
mdd	mədd	give
mss	məss	touch
ʒRR	ʒəRR	pull

b. Nouns

DRb	DəRb	hitting
srʒ	sərʒ	saddle
lʕb	ləʕb	game
frx	fərx	bird

Unlike the items in 52, the ones in 55 are syllabified as CəC.C with the prominent syllable on the left rather than the right edge of the foot, a clear violation of ALIGN-R-σ′. This violation points out to the fact that ALIGN-R-σ′ must be outranked by some other constraints so that forms such as those in 55 could be derived. As it has already been mentioned above, the syllabification of nouns is governed by sonority and that when the sonority of the second consonant of the stem is greater than that of the third, the schwa is epenthesized before the second consonant, resulting in a stem whose right edge coincides with a minor syllable. Thus nouns such as those in 55 present ample evidence that constraints on sonority must be ranked above ALIGN-R-σ′, an issue that constitutes the subject-matter of section 3.6 below. As to the verbs in 55a, we think that satisfying ALIGN-R-σ′ by epenthesizing a schwa between the last two parts of the geminate would split them up, a fact argued against in the relevant literature on geminates (Cf. Guerssel 1978, Benhallam 1980, 1991, Schein and Steriade 1986, Hayes 1986, and Keer 1998, 1999, to cite a few). Here again, we think that the relevant constraint against splitting up geminates would have to outrank ALIGN-R-σ′ as will be shown in section 3.5.1 below.

To recapitulate, it has been shown that CMA items on the pattern (C.CəC) abide by the constraint ALIGN-R-σ′ which requires that the right edge of the stem be aligned with a prominent syllable and that a minor syllable can never be in a prominent position by virtue of the higher-ranking constraint *Min-σ′. It has also been pointed out to the fact that ALIGN-R-σ′ must be dominated by some higher constraint in order to account for verbs with final geminates and a class of nouns on the pattern (CəC.C).

As it has been referred to earlier in this chapter, CMA distinguishes two modes of schwa syllabification: nominal schwa syllabification, which is dependent on the sonority of the consonants constituting the stem, and verb and adjective schwa syllabification. In OT, the appeal to the difference in morphological category in accounting for the differences in syllabic pattern between verbs and adjectives, on the one hand, and nouns, on the other, could be expressed in terms of an alignment constraint requiring that the right edge of the verb and adjective stem be aligned with a prominent syllable. This verb-/adjective-specific constraint is stated as in 56 below:

-56-

ALIGN-R (verb/adjective, σ′) (henceforth ALIGN-R (Vb/Adj, σ′)

> The right edge of the verb/adjective stem must be aligned with the right edge of the prominent syllable.

For the time being, we assume that the verb-/adjective-specific stem-prominent syllable right alignment ranks higher than the general stem-prominent syllable right alignment stated in 51 above. With this ranking, any trisegmental verb stem epenthesizing a schwa between the second and third consonants satisfies both ALIGN-R (Vb/Adj, σ′) and ALIGN-R-σ′. The problem with this ranking comes from words with final geminates which epenthesize a schwa between the first and second parts of a geminate. Consider the following illustration for an input such as /sdd/:

-57-

/sdd/$_{Vb}$	ALIGN-R (Vb/Adj, σ′)	ALIGN-R-σ′	DEP-IO
☞a. s.dəd			*
b. səd.d	*!		*

As the tableau shows, the alignment constraints alone cannot derive the correct output. They wrongly predict that the optimal candidate is [sdəd] instead of [sədd], a fact which calls for a higher-ranked additional constraint that would block epenthesis in the case of geminates. In the next section, we consider this constraint and see how the prosodic word minimality requirement is achieved in non-derived words containing geminates.

3.4 Syllable Structure and Geminates

This subsection is meant to show why epenthesis is blocked in the case of verbs with final geminates, leading to the violation of both ALIGN-R

(Vb/Adj, σ′) and ALIGN-R-σ′. It is also meant to present further evidence for considering the first segment of an initial cluster and the last segment of a final cluster in non-derived forms to be moraic. It is the way CMA resorts to in order to achieve the prosodic word minimality requirements.

There are two different theories about the representation of geminates. The first is the One-Root Theory of Length proposed in Hayes (1989) and McCarthy and Prince (1986). According to this theory, geminates are linked to a single root node as shown in 58 below:

-58-

The One-Root Theory of length


a. Geminate consonant

b. Geminate vowel

The proponents of the One-Root Theory of Length further assume that the root node consists of a single mora and that the double linking is taken care of by general rules of syllabification.

The second view about geminates is expressed by the Two-Root Theory of Selkirk (1990, 1991). According to this theory, geminates are represented with two root nodes that share stricture and place features as shown below:

-59-

The Two-Root Theory of length


a. Geminate consonant

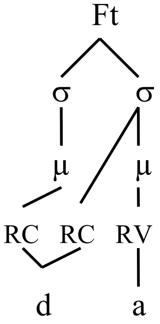
b. Geminate vowel

According to Selkirk, the representations above allow for a straightforward distinction between full and partial geminates. Full geminates involve the sharing of all features; partial geminates, on the other hand, are structures where specifications for laryngeal features or nasality may differ in the two halves.

It is the Two-Root Theory of Length that will be adopted in the present work for the analysis of the cases that involve geminates. The reason for this choice is that the Two-Root Theory treats geminates as a cluster of consonants, something that points out to the possibility of splitting geminates and consequently deriving words with final geminates (see chapter 5 and section 3.5.1 in this chapter). With an underlying one-root representation, there is no reason why we would actually derive a geminate in the case of words with final geminates

Within the Two-Root Theory, a word such as [dda] “he took away” will be represented as follows:

-60-



To encode the Two-Root representation of geminates, a word such as [dda] will be represented underlyingly as /dda/.

It is to be noted here that, contrary to the One-Root Theory, the Two-Root Theory does not say anything about the moraic structure of geminates because this is a property of the language under consideration. In CMA, and as it has already been pointed out, the initial segment of the word in 60 is associated to two root nodes, thus producing initial geminate, the first of which is associated to a mora to satisfy FT-BIN.

The analysis proposed in this section will cover both final and initial underlying geminates.

3.4.1 Final Geminates

In this subsection, we will consider both trisegmental words on the pattern CəC_iC_i and quadrisegmental verbs on the pattern CəCC_iəC_i and show that their analysis goes along the lines proposed for sound verbs of the type /ktb/ .

In 61 below, we present cases of trisegmental nouns and verbs whose final segment is geminated:

-61-

a. Non-derived Nouns

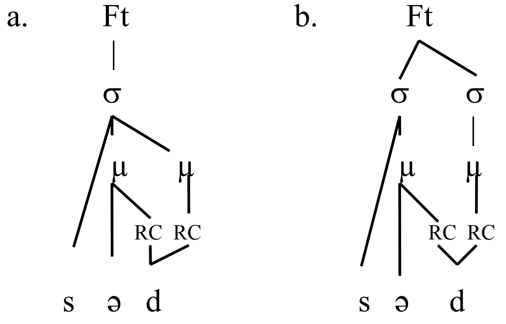
bəqq	bugs
m^{w}əxx	brain
dəmm	blood
fəkk	jaw
nədd	a kind of incense
f^{w}əmm	mouth

b. Non-derived Verbs

sədd	close
ħəll	open
ʕəDD	bite
ʒəRR	pull
d^{w}əqq	knock at
həzz	lift
ħəTT	put down

Given the prosodic organization adopted in the previous section, a word such as [sədd] could have either of the two representations given in 62 below:

-62-



The representation in 62a shows that the word [sədd] is monosyllabic, consisting of a heavy syllable. The other representation shows that the word consists of two syllables, with the second one being a minor syllable associated with the second part of the geminate. Both representations satisfy FT-BIN. However, given the assumptions made above about syllable structure, 62a should be excluded on the ground that it violates *COMPLEX. Note here that the Two-Root theory treats geminates as clusters of consonants and as such they should abide by the constraint *COMPLEX. However, One can spare violation of *COMPLEX by deleting a root consonant of the input, thus resulting in a form such as [səd]. To prevent this deletion, we make recourse to a constraint of the MAX family , namely MAX-RC, which demands that all root consonants of the input be preserved in the output as shown in 63:

-63-

	*COMPLEX	MAX-RC	DEP-IO	*Min-σ
☞a. səd$^{\mu}$.d$^{\mu}$			*	*
b. sədd$^{\mu\mu}$	*!		*	
c. səd$^{\mu}$		*!	*	

Candidates 63b and 63c are ruled out for violating higher-ranked constraints: 63a is excluded because it violates *COMPLEX by allowing the two parts of the geminate to occur as coda; 63c, because it violates the constraint requiring that the root consonants of the input be preserved in the output. 63c could also be excluded because it violates FT-BIN.

Returning back to the distinction between *[s.dəd] and [səd.d], we have pointed out that although [səd.d] violates the specific instantiation of stem-prominent syllable right alignment, it should be considered optimal. *[sdəd] is ruled out because the geminates are split up by schwa epenthesis, a fact which has been argued against in the literature (Guerssel 1978, Benhallam 1980, 1991, Schein and Steriade 1986, Hayes 1986, Keer 1998, 1999, among others). This shows that other relevant constraints ought to be incorporated into the grammar of CMA. In order to derive the correct output, we introduce the constraint NO-SPLITTING which has the effect of blocking schwa epenthesis from splitting geminates in words such as [sədd]. This constraint is stated as follows:

-64-

NO-SPLITTING

Splitting up geminates is prohibited.

This constraint must rank higher than ALIGN-R(Vb/Adj, σ′) and ALIGN-R-σ′ in order to get the optimal candidate [sәd.d]:

-65-

/sdd/$_{Vb}$	NO-SPLITTING	ALIGN-R (Vb/Adj, σ′)	ALIGN-R-σ′	DEP-IO
☞a. sәd.d		*	*	*
d. s.dәd	*!			*

The effect of the NO-SPLITTING constraint is to prevent schwa epenthesis from applying in final geminated verbs. The optimal candidate shows that it is more highly valued to violate the alignment constraints than epenthesize a schwa between the two parts of the geminate.

Nouns such as the ones in 61a could be accounted for in the same way as verbs except that it is only the constraint ALIGN-R-σ′ which is active and not ALIGN-R (Vb/Adj, σ′) as the following tableau for the noun [bәqq] shows:

-66-

/bqq/$_{N}$	NO-SPLITTING	ALIGN-R (Vb/Adj, σ′)	ALIGN-R-σ′	DEP-IO
☞a. bәq.q			*	*
d. b.qәq	*!			*

The shading is meant to show that the concerned constraint is irrelevant since the target is a noun.

The final items we will consider in this subsection are cases of quadrisegmental verbs whose final segment is geminated:

-67-

bərgəg	he spied on
fərtət	he broke into fritters
ʕəntət	he showed stubbornness
ħənZəZ	he gazed at
bəqləl	he gazed at
kənZəZ	he holds his jaws firmly

An input such as /brgg/ will have the candidates listed in the tableau in 68:

-68-

/brgg/$_{\text{Vb}}$	MAX-RC	NO-SPLITTING	ALIGN-R (Vb/Adj, σ′)	DEP-IO
a. bər.gəg		*!		**
b. b.rəg	*!			*
c. bər.g	*!		*	*
☞d. b.rəg.g			*	*

The constraints listed in this tableau wrongly predict that the optimal candidate is 68d instead of 68b. The other two candidates are excluded on the ground that they both violate MAX-RC by deleting a root consonant. So, how is it possible to exclude the candidate in 68d while at the same time establish 68a as optimal?

To answer this question, it is noteworthy to point out here that verbs in CMA, whether they are trisegmental or quadrisegmental, are governed by a prosodic constraint which demand that they consist exactly of two moras. This constraint is stated in 69 below:

-69-

VERB ROOT = [μ μ]

A verb root must correspond to two moras.

To get the correct output, the constraint Verb Root = [μ μ] has to dominate NO-SPLITTING to allow schwa epenthesis to split the final geminates in quadrisegmental verbs as shown in 70:

-71-

/brgg/$_{Vb}$	Verb Root = [μ μ]	NO-SPLITTING	ALIGN-R (Vb/Adj, σ′)	ALIGN-R-σ′	DEP-IO
☞a. bər$^{\mu}$.gəg$^{\mu}$		*			**
b. b$^{\mu}$.rəg$^{\mu}$.g$^{\mu}$	*!		*	*	*

A second competing candidate to the one in 71a would be [b$^{\mu}$.rəgg$^{\mu}$]. This form satisfies the bimoraicity requirement at the expense of *COMPLEX.

To sum up, it has been shown that the Two-Root Theory of Length allows for a better representation of geminates in that it treats them as a cluster of consionants that share common features. It has also been shown that the fact that final geminates in trisegmental verbs are never split by schwa epenthesis results from ranking NO-SPLITTING above ALIGN-R (Vb/Adj, σ′). In quadrisegmentals, on the other hand, verbs with final geminates satisfy ALIGN-R (Vb/Adj, σ′) at the expense of NO-SPLITTING. However, this violation is allowed to secure the higher ranked constraint on verb bimoraicity.

3.4.2 Initial Geminates

Consider the examples with initial geminates given in 72 below:

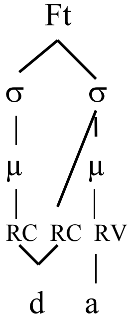
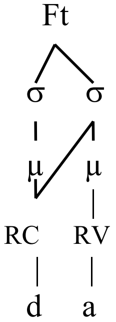
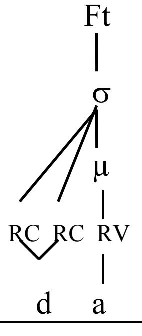
-72-

a.	DDaR < l-DaR	the house
	ssma < l-sma	the sky
	nnas < l-nas	people
	ddir < t-dir	you do
	DDRəb < t-DRəb	you hit
	nnʕəs < n-nʕəs	we sleep
	nnʕəs < n-nʕəs	we engrave
b.	dda	he took
	bb^{w}a	my father
	mm^{w}i	my mother

The items in 72a are cases of heteromorphemic geminates; they arise whenever two coronal segments come into contiguity. The items in 72b are cases of tautomorphemic geminates and these are the only items that occur in the language. Our objective here is not to account for the process of gemination but only to consider the cases that might pose a problem of word minimality requirement. For a more detailed account of gemination in MA, the reader is referred to works such as Benhallam 1980, 1991, Rguibi 1990 and El Himer 1993.

In order to account for words with initial geminates, we won't make any recourse to the alignment constraints since these are irrelevant in deciding about the optimal candidate. What we need are in fact the constraints FT-BIN, MAX-RC, *COMPLEX, DEP-IO and *Min-σ. In the tableau below, we show how a representative item such as [dda] from the list in 72b is obtained:

-73-

/dda/	FT-BIN	*COMPLEX	MAX-RC	*Min-σ
☞a. 				*
b. 			*!	*
c. 	*(!)	*(!)		

The Two-Root Theory, coupled with the relevant constraints considered above, allows us to derive the optimal candidate in 73a which incurs a violation mark for *Min-σ to satisfy FT-BIN. The candidate in 73b satisfies FT-BIN but is ruled out because it incurs a fatal violation of MAX-RC by deleting a root consonant node of the input. Finally, the candidate in 73c associates both root consonants to the syllable node and is excluded because it violates either FT-BIN or *COMPLEX.

To sum up, it has been shown that initial geminates, and more particularly words on the pattern C_iC_iV are treated in the same way as words on the pattern CCəC or CCV. The first part of the geminate is always associated with a minor syllable to satisfy both *COMPLEX and FT-BIN.

In the next section, we will see if the constraints considered above can account for cyclic syllabification in verbs and adjectives in CMA.

3.5 The Problem of Cyclic Syllabification

It has been pointed out in section 2 above that syllabification in CMA verbs and adjectives should be allowed to apply cyclically in order to get the attested output. In this section, we will reconsider this problem in the light of the OT constraints stated so far and see if their ranking is capable of generating the correct output. But before we do that, let us consider the adjective and the verb paradigms given in 74:

-74-

a. Adjectives

Masculine	*Feminine*	*Gloss*
ʕrəʒ	ʕərʒ-a	lame
Smək	Səmk-in	deaf
SfəR	SəfR-a	yellow
xDəR	xəDR-in	green
zRəq	zəRqa	blue
kħəl	kəħla	black

b. Perfective form of the verb [ktəb] “write”

1sg.	ktəb-t	1pl.	ktəb-na
2sg.	ktəb-ti	2pl.	ktəb-tu
3sg.mas.	ktəb	3pl.	kətb-u
3sg.fem.	kətb-at		

c. Perfective form of the verb [ʒəRʒəR] “trail”

1sg.	ʒəRʒəR-t	1pl.	ʒəRʒəR-na
2sg.	ʒəRʒəR-ti	2pl.	ʒəRʒəR-tu
3sg.mas	ʒəRʒəR	3pl.	ʒəRƷR-u
3sg.fem.	ʒəRƷR-at		

The items in 74a represent a class of trisegmental adjectives on the pattern CCəC. When a vowel-initial suffix is added, the final consonant of the stem (CCəC) ceases to function as a coda of the schwa syllable and is adjoined as an onset to a syllable whose nucleus is the vowel of the suffix, thus observing the ONSET constraint. The same thing can be said about the third person feminine singular and the third person plural in the verb paradigms in 74b and 74c. These items point to the fact that ONSET must dominate ALIGN-R since the satisfaction of ONSET leads to the misalignment of the right edge of the stem and the right edge of the syllable and therefore violation of ALIGN-R.

Within the derivational model of syllabification, the forms that have received special treatments are the 1sg. of trisegmental verbs and the 1sg., 3sg.fem., and 3pl. of quadrisegmental verbs. For example Benhallam (1990a) assumes that syllabification has to apply cyclically in order to derive the correct output. We give below the derivation of [kətbt] “I wrote” and [ʒəRƷRu] “they trailed”.

-75-

Input	[[ktb]t]	[[ƷRƷR]u]
	First cycle	
Syllabification	.k.təb.	.ʒəR.ʒəR.
	Second Cycle	
Affixation	.k.təb.-t	.ʒəR.ʒəR.-u
Syllabification	.k.təb.t.	.ʒəR.ʒə.Ru
Syllabification	—	.ʒəR.ʒ.Ru.
Output	[kətbu]	[ʒəRƷRu]

Recall that the schwa in MA does not occur in open syllables and that explains why it drops in the stem [ʒəRʒəR] after the affixation of [-u].

The analysis in 75 is operational in the sense that an input form has to go through different intermediate stages before it reaches the final stage of output representation. Such a stand is therefore incompatible with the principles of OT, namely that of parallel evaluation of candidates. Moreover

Let us now see if the constraints developed in the previous section could account for the problematic cases stated above. First, consider a trisegmental verb to which the first person singular marker is affixed. The competing candidates for the input /ktb-t/ are listed in the tableau below:

-76-

/ktb-t/	*COMPLEX	ALIGN-R (Vb/Adj, σ′)	DEP-IO	*Min-σ
a. k.təb.t		*	*	**
💣b. kət.bət			**	
c. ktəb.t	*!	(*!)	*	*
d. k.təbt	*!		*	*

This ranking wrongly predicts that the optimal candidate is 76b where the right edge of the verb aligns with a prominent syllable. 76a is excluded because it right-aligns a minor syllable which, as has been argued above, can never be prominent because of undominated *Min- σ′. The candidates in 76c and 76d are both excluded on the ground that they violate *COMPLEX: 76c has a complex onset while 76b has a complex coda. The form in 76c could also be excluded because it violates ALIGN-R (Vb/Adj, σ′).

Trisegmental verbs show that the constraints developed above are not sufficient enough to derive the optimal form. The same thing could be said about quadrisegmental affixed verbs. For example, an input such as /ʒRʒR-u/ may have the following output candidates:

-77-

/ʒRʒR-u/	*COMPLEX	ALIGN-R (Vb/Adj, σ′)	DEP-IO	*Min-σ
☞ a. ʒəR.ʒ.Ru			*	*
☜b. ʒ.Rəʒ.Ru			*	*
c. ʒRəʒ.Ru	*!		*	
d. ʒəR.ʒə.Ru			**!	

The candidates in 77c and 77d are both excluded for different reasons: 77c incurs a fatal violation of *COMPLEX, whereas 77d is excluded because it has resorted to schwa epenthesis to avoid a complex onset, thus incurring an additional violation mark of DEP-IO and resulting in an open schwa syllable. The forms in 77a and 77b tie in everything and as such the optimal form 68a can be determined neither on the basis of the constraints listed in this tableau nor on the other constraints seen so far.

Both trisegmental and quadrisegmental affixed verbs show that cyclic syllabification in CMA poses a problem for the theoretical framework in the version adopted so far. This calls for a revision or extension of the this framework. Suffice it here to raise the problem; it will receive due consideration in chapter four where tit will be shown that cyclic phenomena are cases that necessitate reference to a different kind of faithfulness relation holding between the derived output form and the simple base form. In particular, it will be shown that in order to derive the correct output, reference must be made to an output-output constraint requiring that the syllable initial segments of output correspond to the syllable initial segments in the base form.

3.6 Sonority and Syllabification

The final case we will consider in this chapter is that of nominal schwa syllabification. Consider some of the nonderived nouns given in 78 below:

-78-

a.	kəlb	dog
	dənb	sin
	bərd	wind

	fərx	bird
	ʃəmʃ	sun
	DəRb	hitting
	ləʕb	game
	qərd	monkey
	γərs	plant
	ħəRb	war
	qəlb	heart
	nəħs	bad luck
	bənt	girl
	kərʃ	stomach
b.	rʒəl	leg
	ktəf	shoulder
	STəl	bucket
	ħbəl	rope
	bγəl	mule
	wtəd	peg
	zbəl	rubbish
	qbəR	tomb
	Dbəʕ	hyena
	bħəR	sea
	sbəʕ	lion
	qfəz	cage
	ħTəb	firewood
	wdən	ear
c.	γnəm	sheep
	tmən	hang-over
	gməl	lice
	ʒməl	camel
	qməR	gambling
	tməR	dates
	wsəx	dirt
	ʃdəg	loaf (of bread)
	ftəq	hernia
	smən	preserved butter
	nmər	tiger

The schwa in the above items is dependent on the sonority of the second and third consonants of the root**.** It is epenthesized before the second consonant of the root if its sonority is greater than that of the third consonant (78a). If the sonority of the third consonant is greater than that of the second consonant, the schwa is epenthesized before the third consonant (78b). Also, the schwa is epenthesized before the third consonant if its sonority equals that of the second consonant (78c). What the items in 78b and 78c show is that right-to-left directionality of schwa syllabification is also observed in nouns and this through satisfaction of the constraint ALIGN-R-σ′ demanding coincidence of the right edge of the stem with the right edge of a prominent syllable. The only cases where ALIGN-R-σ′ is violated is when sonority is at stake. This points out to the fact that ALIGN-R-σ′ must rank below sonority. The question that should be asked here is the following: how is it possible to express the relative sonority of consonants in the theoretical framework adopted in the present work?

To answer this question, it should be noted that the schwa in CMA is moraless on its own and that it acquires a moraic status only in combination with a following consonant in the same syllable. Such an assumption excludes the possibility of having schwas in open syllables, something which is true about MA (Benhallam 1980, 1988, 1990a; Hammoumi 1988, Al Ghadi 1990, Boudlal 1993, 1998 and others). In other words, all schwa syllables have a coda, and it is the coda which determines the epenthesis of the schwa. The behavior of the schwa in 78 is reminiscent of what Clements (1988:68) calls the Dispersion Principle which he states as follows:

-79-
The Dispersion Principle:

a. The preferred initial demisyllable maximizes sonority dispersion.
b. The preferred final demisyllable minimizes sonority dispersion.

Demisyllables according to Clements are overlapping portions of a syllable sharing the peak. For example CV is an initial demisyllable while VC is a final demisyllable [9].

What interests us here are final demisyllables which Clements (1988:69) ranks as follows:

-80-
Final demisyllables

V ➢ VG ➢ VL ➢ VN ➢ VO

(G=glide, L=liquid, N=nasal and O=obstruent, and ➢ means better than)

---

[9] According to Clements (1988) V is both an initial and final demisyllable. Syllables on this pattern are called one-member demisyllables.

What 80 basically states is that codaless syllables rank high and that if there has to be a coda, the difference between the sonority of the nucleus and that of the coda in a syllable should not be significant. In other words, the closer the sonority of the coda is to that of the nucleus the better.

The CMA data in 78 seem to abide by the ranking in 80 except that final demisyllables of the type V do not occur if V is a schwa. On a parallel basis, the constraints on CMA final ə-demisyllables can be stated as in 81. We assume that a ranking should be established within the class of obstruents whereby fricatives (F) dominate stops (S):

-81-

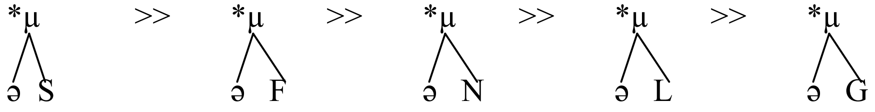
Final ə-demisyllables in CMA

əG >> əL >> əN >> əF >> əS

Recall from our analysis that both the schwa and the following consonant, i.e. the coda, are associated with a single mora. If this is the case, the ranking in 81 could well be expressed in terms of negative constraints on CMA ə-demisyllables. The ranking of these negative sonority constraints is given in 82 below:

-82-

SONORITY (in nouns)



Note that the sonority constraints in 82 are to be distinguished from
H-NUC [10]. They reflect the idea that the optimal coda of schwa syllables is one with a higher sonority value.

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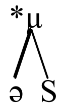
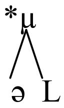
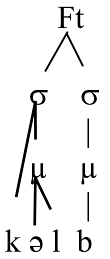
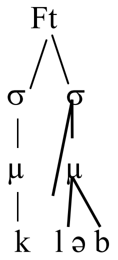
[10] My interpretation of H-NUC differs from that of Al Ghadi (1994) who assumes that a C occupies a nucleus position if it is exclusively dominated by a mora in word-initial or coda positions (cf. C.CV and CƏC.C, where the moraic consonant is underlined) or if it is jointly with a schwa dominated by a mora (as in CƏC.CƏC, where both ƏC are associated with a single mora. While we mainatin, following Al Ghadi, that H-NUC is incurred when a mora dominates C, we believe that sequences such as ƏC should be explained by sonority constraints of the types proposed in 82 where the schwa is placed before the most harmonic coda in terms of sonority.

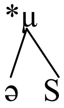
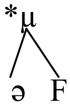
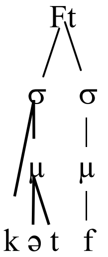
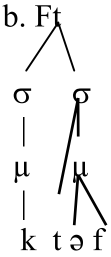
The sonority constraints in 82 along with the constraints developed so far can adequately account for the nominal items in 78. Recall from our discussion above that nouns on the pattern (CəC.C) violate ALIGN-R-σ′ because the right edge of the stem aligns with a minor syllable which cannot be prominent. This points out to the fact that the sonority constraints must rank higher than ALIGN-R-σ′. As to the constraint ALIGN-R(Vb/Adj, σ′), it does not have any visible effect on nouns and as such will not be included in the analysis. In the tableau below, we consider the different parses of the input /klb/$_N$, where the sonority constraints outrank ALIGN-R-σ′.

-83-

/klb/$_N$			ALIGN-R-σ′.
☞a. 		*	*
b. 	*!		

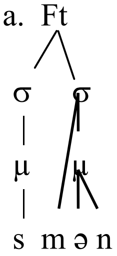
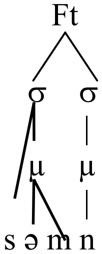
Now consider a case where the schwa is epenthesized between the second and third consonants of the root and where the sonority of the third consonant is greater than that of the second. An input noun such as /ktf/$_N$ would have the candidate parses represented in 84.

-84-

$/ktf/_N$			ALIGN-R-σ′
a. 	*!		*
☞b. 		*	

The last case of trisegmental nouns we will consider is one where the sonority of the second consonant equals that of the third. Here the schwa is epenthesized between the two consonants and it is the constraint ALIGN-R-σ′ which is decisive. Consider the two parses of the input /smn/ given in 85 below:

-85-

/smn/$_N$	*μ ə N	ALIGN-R-σ′
☞a. 	*	
b. 	*	*!

Wherever the schwa is placed (before [n] or before [m]), the constraint *μ/əN is violated. Although ALIGN-R-σ′ is dominated, it is still active in the language in that it enables us to determine the appropriate placement of the schwa in trisegmental nouns whose second and third consonants have equal sonority.

The syllabification of quadrisegmental nouns on the pattern CCCC is generally CəC.CəC as shown in 86 below:

-86-

	Root	*Stem*	*Gloss*
a.	ʃrʒm	ʃərʒəm	window
	mdfʕ	mədfəʕ	canon
	tnbr	tənbər	stamp
b	fndq	fəndəq	hotel
	mħbq	məħbəq	flower pot
	mslm	məsləm	Muslim

In non-derived quadrisegmental nouns such as the ones given in 86, one wonders whether it is necessary to refer to the sonority constraints since there is no other way for the sequence CCCC to syllabify except as CəC.CəC. Syllabifying the sequence as CCəCC would violate *COMPLEX. Trying to avoid having complex margins by syllabifying the sequence as C.CəC.C would constitute a violation of ALIGN-R-σ′ as shown in the constraint tableau below:

-87-

/mħbq/$_N$	*COMPLEX	ALIGN-R-σ′.	DEP-IO	*Min-σ
☞a. məħ.bəq			**	
b. mħəbq	*!		*	
c. m. ħəb.q		*!	*	**

Now let us consider quadrisegmental suffixed nouns to see if the constraints developed so far can generate the correct output. First consider the examples in 88:

-88-

a.	snsl-a	sənsla	zip
	ʃrʒm-u	ʃərʒmu	his window
	tnbr-i	tənbri	my stamp
	brdʕ-a	bərdʕa	saddle-bag
b.	mslm-in	msəlmin	Muslims
	ʃfnʒ-at	ʃfənʒat	doughnuts
	mTRq-a	mTəRqa	hammer
	mγ^{w}rf-a	mγ^{w}ərfa	ladle
	mʕlq-a	mʕəlqa	spoon
	mbxr-a	mbəxra	censer

In these items, the final consonant of the root is syllabified as the onset of a syllable whose nucleus is the vowel of the suffix; the remainder is syllabified much in the manner of the trisegmental nouns considered above. The schwa is epenthesized before the second consonant of the root if its sonority is greater than that of the third consonant (88a), and before the third consonant if its sonority is greater than that of the second (88b). The constraint tableau in 89 gives some of the candidate parses of the input /mslm-in/.

-89-

/mslm-in/$_N$	*COMPLEX	*μ ə S	*μ ə N	*μ ə L	ALIGN-R-σ′
☞a. m.səl.min				*	
b. msəl.min	*!			*	
c. məs.ləm.in		*!	*		

The candidate in 89c can further be excluded because the right-hand syllable is left without an onset, something which constitutes a fatal violation of undominated ONSET. Notice the irrelevance of ALIGN-R-σ′ in determining the optimal parse. Once again, the constraints developed in this paper can adequately account for noun as well as adjective and verb syllabification.

To sum up, the constraints needed to account for CMA syllable structure are given below:

-90-

a. Undominated constraints: FT-BIN, *COMPLEX, MAX-IO, PARSE-seg, ONSET, SONORITY (in nouns), *Min-σ′, ALIGN-R (Vb/Adj, σ′) and VERB ROOT =[μ μ].

b. Dominated constraints: DEP-IO, NO-CODA, H-NUC, *Min-σ, ALIGN-R, ALIGN-R-σ′ and NO-SPLITTING.

The domination relation among these constraints is given in 91:

-91-

a. ONSET, MAX-IO, PARSE-seg>>DEP-IO>>NO-CODA

b. FT-BIN, *COMPLEX>>DEP-IO>> *Min-σ, H-NUC>>NO-CODA

c. *Min-σ′>>ALIGN-R (Vb/Adj, σ′)>>ALIGN-R-σ′>> ALIGN-R>>DEP-IO

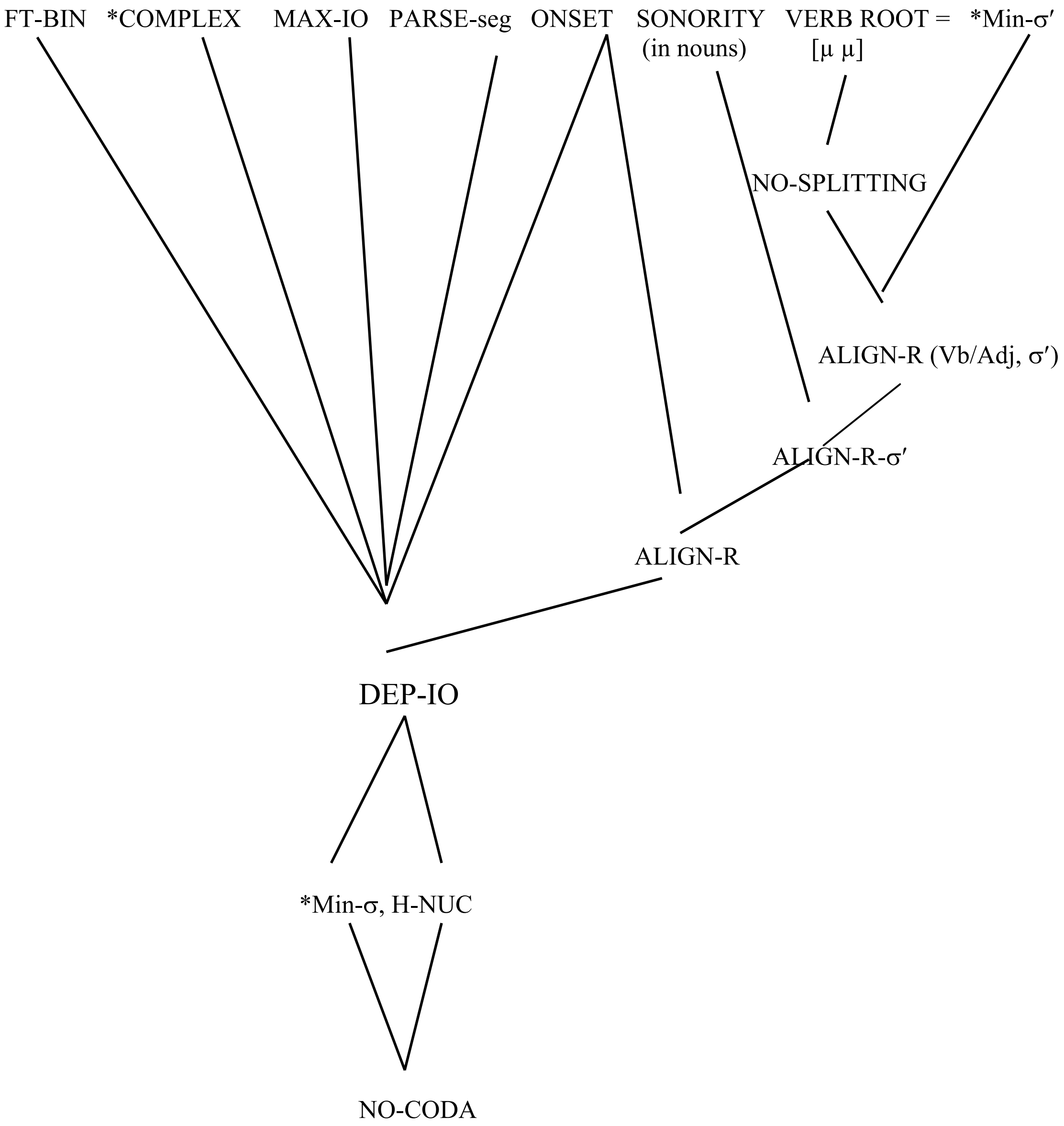
d. VERB ROOT=[μ μ]>>NO-SPLITTING>> ALIGN-R (Vb/Adj, σ′)>>ALIGN-R-σ′

e. ALIGN-R (Vb/Adj, σ′), SONORITY$_N$>> ALIGN-R-σ′

The constraints in 91 are reproduced in the hierarchical structure in 92:

-92-

Constraint hierarchy in CMA



4. CONCLUSION

This chapter has tried to account for CMA syllable structure within the OT constraint-based framework. It has been shown that such a framework, which derives syllabic well-formedness from the interaction of constraints belonging to UG, is far better than a step-by-step syllable structure building algorithm, especially in the problematic cases of schwa syllabification.

While we maintain the previous scholars' assumptions that schwas are epenthetic and dependent on syllable structure as well as on the sonority of the consonants of the base if this happens to be a noun, the analysis offered in this chapter has an explanatory power since it shows that prosodic structure assignment in CMA is governed not by rules but by constraints such as the ones listed in 92. A constraint-based analysis offers a straightforward analysis to some of the recalcitrant problems like directionality of syllabification and the representation of geminates and their contribution to the achievement of prosodic word minimality requirement. Directionality of syllabification has been shown to derive from alignment constraints such as ALIGN-R (Vb/Adj, σ′), ALIGN-R-σ′ or else from ALIGN-R. It has been shown that in a large number of trisegmental items, the schwa is epenthesized before the third consonant of the root and this follows from the constraint requiring that the stem be iambic. It has also been shown that the difference between verb and adjective schwa syllabification, on the one hand and noun schwa syllabification on the other could be accounted for by ranking the verb-/adjective stem-prominent syllable alignment above the general stem-prominent syllable right alignment. In both cases, it has been shown that a minor syllable can never be in prominent position, a prohibition ensured by the constraint *Min-σ′. As to minimality requirement it has been shown that in the case of non-derived words, the first segment of an initial cluster or the second segment of a final cluster must be moraic and therefore form a minor syllable on its own. By adopting the Two-Root Theory of length, the proposed analysis also nicely accounts for words with initial and final geminates. It has been shown that the fact that final geminates in trisegmental stems are never split up by schwa epenthesis follows from ranking ALIGN-R (Vb/Adj, σ′) and ALIGN-R-σ′ immediately below NO-SPLITTING. This constraint is violated only when the constraint on verb bimoraicity is at stake as is the case with quadrisegmental verbs with final geminates.

The chapter has also shown that nominal cases, where schwa syllabification depends on the sonority of the consonants in the input, can adequately be accounted for in terms of universal constraints demanding that the sonority of the consonant serving as the coda of schwa syllables be as close as possible to that of the nucleus. It has also been shown that directionality plays an important role not only in verb and adjective schwa syllabification but also in nominal schwa syllabification, especially in trisegmental roots whose second and third segments have the same sonority value. Here, we have argued that ALIGN-R-σ′ decides in favor of the candidate that best satisfies the constraint.

In sum, two types of constraints have been distinguished: dominated constraints which are DEP-IO, NO-CODA, H-NUC, ALIGN-R (Vb/Adj, σ′), ALIGN-R-σ′, ALIGN-R, NO-SPLITTING and *Min-σ; and undominated constraints which are ONSET, MAX-IO, PARSE-seg, *COMPLEX, SONORITY in nouns, *Min-σ′, VERV=[μ μ] and FT-BIN which is satisfied in CMA by associating the first consonant of CCV or CCəC to a mora as proposed by Al Ghadi (1994). We have argued that the undominated constraints are never violated and as such they are ranked at the top of the ranking scale. Throughout this chapter, it has been argued that the relative ranking of these constraints is what determines the right syllabic output.