Broken Plural Formation in Moroccan Arabic: A Stratal Optimality Theory Account

by

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ABSTRACT

The plurals of Moroccan Arabic in general are divided into two types: sound and broken. The former is formed through a process of suffixation, while the latter usually involves an internal change in the singular stem (Harrel, 1962). Phonological patterning in broken plurals is complex. The only unified account of Moroccan Arabic broken plural formation has been proposed by Al Ghadi (1990) using the framework of Autosegmental Theory. As for Classical Arabic, McCarthy and Prince (1990) proposed a theory of Prosodic Morphology to account for broken plurals. Later, McCarthy (1997) proposed an analysis of this phenomenon using OUTPUT-OUTPUT correspondence in Optimality Theory. While these proposals are successful in accounting for some broken plural patterns in Classical Arabic, this thesis shows that they are insufficient to account for broken plural formation in Moroccan Arabic. A Stratal OT analysis of this phenomenon is proposed as an alternative account. The thesis adopts the representational assumptions made by Al Ghadi (1990) regarding the syllable template of Moroccan Arabic. The analysis proposed assumes that there are two main levels to broken plural formation: the stem level and the word level. At the stem level, the infixation of the broken plural morpheme takes place, while syllabification and epenthesis occur at the word level. Therefore, this thesis provides an attempt to account for the major broken plural patterns in Moroccan Arabic, i.e. CCVC, CCVCa, and CCVCeC, using Stratal OT (Kiparsky, 2000; Bermúdez-Otero, 2003; Rubach, 2003; among others). The analysis proposed makes use of faithfulness constraints that require identity between inputs and outputs of each level (e.g. MAX-IO, DEP-IO, CONTIGUITY, and so on) and markedness constraints that regulate the prosodic well-formedness of Moroccan Arabic broken plural forms (e.g. ONSET, ALIGN, and so on).

ACKNOWLEDGEMENTS

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Chapter 1: Introduction

This thesis will provide an investigation and analysis of broken plural formation in Moroccan Arabic (henceforth MA). The thesis will present the major productive broken plural patterns in MA and demonstrate how previous literature fails to account for these patterns sufficiently. An alternative Optimality Theory (henceforth OT) account will be proposed to deal with broken plurals in MA. This account will rely on constraints on prosodic structure as well as interleaving of phonological and morphological operations. It will be shown that such an account can successfully deal with the major broken plurals in MA.

Plurals in Arabic are divided into two main types: sound and broken. While sound plurals are formed through a simple suffixation process, broken plural formation is one of the most complex structures in the morphology of Arabic. Due to its rich morphological system, the Arabic language is known for a large number of broken plural patterns; some of these patterns are more frequent than others, and some are similar in terms of their structure, while others differ from one another in a variety of respects. Moreover, the non-concatenative processes involved in forming broken plurals in Arabic are also a key factor behind the complexity of this system. Unlike sound plurals, which are formed through morpheme suffixation, broken plurals involve an internal modification in the singular stem; this modification often takes the form of vowel infixation and/or vowel change. As a result, approaching this phenomenon formally has always represented a major challenge to linguists.

While the focus of most previous accounts of broken plurals has been on Classical Arabic (henceforth CA), this thesis proposes an account of broken plurals in MA, a variety of Arabic

spoken in Morocco. The focus on CA seen in the literature stems from the fact that CA is the standardized literary form of the language. Since CA is the only written form of the Arabic language, it is widely used in literature, media, education, and religious discourse in the Arab world. CA, however, is not the native language in any Arab population; every country in the Arab world has a unique spoken Arabic variety. These varieties differ from CA and from one another depending on the geographic area where they are spoken and the existence of other languages spoken in those countries. One of these spoken Arabic varieties is MA, the native language of the majority of population in Morocco. The latter is influenced by two languages: CA and Berber.

The purpose of this thesis is to develop an account of how broken plurals in MA are formed. First, the thesis reviews the previous accounts of this phenomenon in both CA and MA (McCarthy, 1983; McCarthy & Prince, 1990; McCarthy, 1997; and Al Ghadi, 1990) and shows how these accounts are inadequate or unsatisfactory when applied to MA broken plural data. As an alternative account, the thesis proposes an OT analysis of this phenomenon. More specifically, broken plurals in MA are analyzed using the framework of Stratal OT. It will be shown that this model of OT not only overcomes the drawbacks of the previously proposed theoretical frameworks, but can also efficiently account for broken plural formation using less complicated procedures than those frameworks.

This thesis is divided into six chapters. The first chapter is a brief introduction that presents the phenomenon of broken plurals and states the purpose behind the thesis. The second chapter contains two main parts. The first one provides a brief overview of the MA sociolinguistic situation, phonological system, and the morphology of the language. The second one is a classification of MA plurals in which both sound and broken plurals are described in detail. In the third chapter of this thesis, a review of the literature on broken plural formation in both CA and MA is presented.

The most significant works on this phenomenon will be reviewed along with their drawbacks and limitations. The fourth chapter presents the framework adopted for the present thesis —Stratal OT— and shows how it can efficiently account for broken plurals in MA. In the fifth chapter, a detailed analysis of broken plurals in MA is presented. This chapter consists of three main parts. The first one is devoted to the stem-level OT analysis of broken plurals. The second one presents the word-level analysis. The third part shows how an analysis of MA broken plurals using a parallel approach to OT cannot account for the data. The last chapter of this thesis is a conclusion that discusses the findings of the proposed analysis and the implications it has on the morphophonology of both MA and CA.

Chapter 2: Moroccan Arabic

2.1. Introduction

MA is a member of the Semitic group of the Afro-Asiatic language family. MA is the native language of more than 80% of the population in Morocco (30 million people). Ennajii (2002) states that MA is diachronically derived from CA and is also influenced by Berber which existed in Morocco before CA. The influence of Berber (also called Tamazight) is due to the fact that it's the native language of 15-25 million people in North Africa. In Morocco, approximately 6 million of the population speak Berber as a first language (Kossmann & Stroomer, 1997). Berber is also a first language of populations in Algeria, Libya, Niger, Mali, Tunisia and Egypt. There are three varieties of Berber in Morocco: Tashlhiyt, Tamazight, and Tarifit. Each of these varieties is spoken in a particular region in the country. MA, however, is the language of the mass media and is used in daily life by the majority of the Moroccan population, so it holds the predominant position over both CA and Berber. What is more, MA has recently appeared in written form especially on the internet and advertisements.

This chapter is an overview of MA phonology and morphology. The second section will present both the consonantal and vocalic inventories of MA. The third section will be devoted to MA syllable structure and prosody and how they are different from those of CA. The fourth section will provide a brief overview of MA morphology; it will show how similar it is to CA morphology in the most part. The fifth section will be devoted to gender and number in MA. I will present a

classification of gender in the language and will go over MA plurals in detail. The various MA plural patterns will be provided and classified based on their frequency of occurrence.

2.2. The Phonemic Inventory of Moroccan Arabic

The phonological system of MA is characterized by its rich consonantal system and its limited vocalic system. Although most of the consonants in MA come from CA, there are some differences between both systems. For instance, a consonant class that CA is known for and that was lost in MA is interdental (/ð/ and / θ /); these are changed to the alveolar stops d and t, respectively (Heath, 1997). The underlying consonantal system of MA consists of 27 consonants represented in Table 1.

Table 1: The Consonantal System of Moroccan Arabic

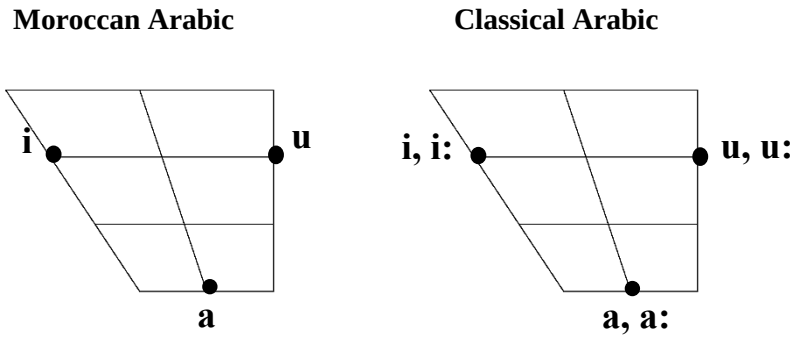
	Labial		**Alveolar**		**Palato-alveolar**		**Velar**		**Uvular**		**Pharyngeal**		**Laryngeal**	
	+v	**-v**	**+v**	**-v**	**+v**	**-v**	**+v**	**-v**	**+v**	**-v**	**+v**	**-v**	**+v**	**-v**
Stops Emphatic stops	b B		d D	t T			g	k		q				
Fricatives Emphatic fricatives		f	z Z	s S	ʒ	ʃ			ɣ	x	ʕ	ħ		h
Nasals	m		n											
Liquids Emphatic liquids			l, r (L), R											
Glides					J		w							

MA is also known for its emphatic consonants. Emphatics are a set of consonants whose primary articulation occurs in the coronal region; they are also known to have a secondary articulation that involves the retraction of the tongue into the oropharynx. This secondary articulation distinguishes emphatics from their non-emphatic counterparts. These sounds are also called pharyngealized since the articulation of these sounds involve narrowing the pharynx. In

addition to the coronal emphatics that CA is known for, MA is also known for the emphatic consonants /B/ and /R/.

Unlike CA that has three short vowels (/a/, /u/, and /i/) and their corresponding long vowels, the underlying vocalic system of MA consists of the three full vowels /a/, /u/, and /i/(1). These vowels correspond to CA long vowels and diphthongs. CA short vowel are either disappeared or reduced to schwas in MA (Heath, 1997). The schwa in MA, however, is not phonemic. It's, rather, epenthesized for syllabic purposes (Benhallam, 1980, 1990; Al Ghadi, 1990; Boudlal, 2000; among others). In most cases of words that have three consonants and lack full vowels, the schwa is inserted before the final consonant or after the initial consonant (C_CC and CC_C) as in words like ʒbəl (from CA ʒabal) and bənt (from CA bint).

(1)

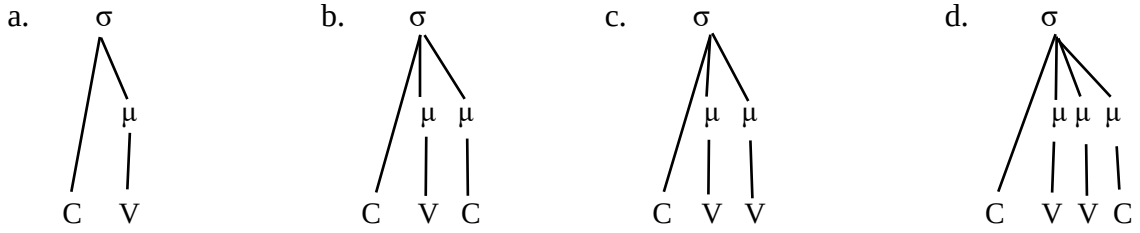


MA phonology is heavily influenced by Berber. The latter also has three short vowels (a, i, and u) and the schwa as an epenthetic vowel. In terms of its consonantal inventory, Berber has bilabial, dental, palatal, velar, uvular, pharyngeal, and laryngeal consonants. Some of these consonants are borrowed from CA (e.g. S, T, Q, ħ and ʕ) or Spanish and French (e.g. p). A large number of consonants have been borrowed from Arabic or European languages, e.g., S, T, Q, ħ, and ʕ from Arabic and p from Spanish or French. Berber is also known for its labialized phonemes (k^o, g^o, x^o, $ɣ^o$, and q^o).

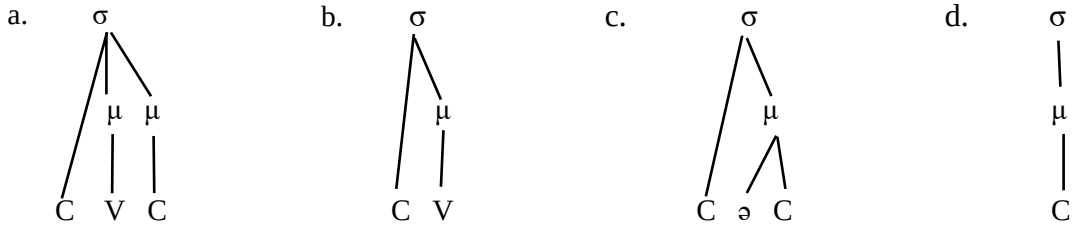
2.3. Moroccan Arabic Syllable Structure and Prosody

As mentioned in the previous section, one of the major differences between MA and CA is their vocalic inventory. The absence of long vowels in MA and the existence of the epenthetic schwa[1] that MA is known for are reflected in the syllable structure of both languages. CA has four syllable shapes. It has monomoraic light syllables of the form CV (2a), bimoraic heavy syllables of the forms CVC (2b) or CVV (2c), and trimoraic superheavy syllables of the form CVVC (2d). MA, on the other hand, distinguishes between bimoraic heavy syllables CVC (3a) and monomoraic light syllables, which are divided into three forms; in the first, the mora dominates one segment (3b); in the second, the mora dominates the schwa and a following consonant (3c); in the third, the mora dominates one consonant (3d).

(2) Syllable Shapes in CA



(3) Syllable Shapes in MA

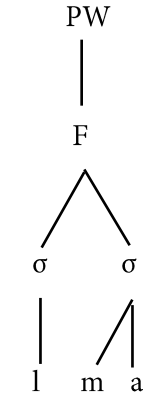


[1] According to Al Ghadi (1990) and Boudlal (2001), the schwa epenthesis in nouns depends on the sonority of the consonants surrounding it; Al Ghadi (1990) observes that schwa epenthesis occurs before the most sonorous consonant in the noun. In the root /bnt/, for instance, the schwa is epenthesized between the first and second consonants in the noun bənt (‘girl’) since /n/ is more sonorant than /t/; in the root /ʕql/, on the other hand, the schwa is epenthesized between the second and third consonants in the noun ʕqəl (‘mind’) since /l/ is more sonorant than /q/.

The representation in (3c) originates from an assumption by Al Ghadi (1994) and a proposal made in Jebbour (1996); the latter claims that a closed syllable whose nucleus is a consonant should be monomoraic. As for (3d), Boudlal (2001) claims that the first member of an onset cluster forms a degenerate syllable, i.e. should be assigned moraic structure, as does the second member of a coda cluster as in the words [**ʕ**$^{\mu}$.qəl$^{\mu}$] and [ben$^{\mu}$.**t**$^{\mu}$]. As evidence for his claims, Boudlal refers to some constraints on MA syllabification and prosody. In MA, a lexical word is equivalent to a prosodic word (Prince & Smolensky, 2004) and the latter can minimally contain one foot, and since feet must be binary in MA, the only way to account for the well-formedness of words like (4a) is to assign moraic structure to the first member of its onset cluster (Al Ghadi, 1994). The word *lma* ('water') is comprised of *l* ('the') and *ma* ('water'), but, since CV syllables cannot form a lexical word in MA, *ma* on its own is ungrammatical (4b) and must always be preceded by the definite article *l*. In this thesis, Boudlal's (2001) analysis of MA prosodic structure will be adopted.

(4)

a.



/lma/ 'water'

b.

*/ma/ 'water'

Words like (4a) show that the units of prosody in MA are structured in a different manner from those of CA. The notion of minimal units of prosody, for instance, differs from one language to another. In CA, a minimal word corresponds to two moras, a heavy syllable (CVC) or (CVV) or a sequence of two light syllables (CVCV). The notion of minimal category can also be applied to

MA. According to Al Ghadi (1990), the minimal word in MA corresponds to a minimal foot and is equivalent to two moras. Minimal feet in MA can have four different forms: CCV, CCəC, CVC, or CəCC. The first and second forms contain a degenerate syllable followed by the light syllables CV and CeC respectively, while, in the fourth form, the light syllables precede the degenerate syllable.

The main reason behind the differences between MA and CA in syllabification and prosody is the influence of Berber on MA. In addition to having the same vocalic system as Berber, the loss of CA vowels in MA words can also be attributed to Berber's influence on the language since most varieties of Berber have the syllable shapes CV, CəC, and CVC that MA has. What is more, it is possible to have some consonant classes as the nucleus of a syllable in Tashlhiyt, a variety of Berber spoken in southwestern Morocco (Alderete et al., 2015). In words like *tfkkar* ('to be thinking'), for instance, the fricative sound [f] is the nucleus of the syllable *tfk*, which in other languages would have an epenthetic vowel as the nucleus.

2.4. A Brief Overview of Moroccan Arabic Morphology

In general, morphological processes in Semitic languages are divided into two types, concatenative and non-concatenative. In the former, word formation is done by stringing morphemes together as in prefixation, suffixation, or circumfixation. In the latter, word formation does not take the form of linear affixation; examples of non-concatenative processes include reduplication, infixation, morphologically-governed ablaut, and suprafixation (McCarthy, 1981). In the earliest grammatical analysis of CA, a system called 'roots' and 'patterns' was used for characterizing both concatenative and non-concatenative morphological processes. In this system, words are constructed on a basic consonantal root. This latter occurs in patterns with various vowels

and additional, non-root consonants. The root represents the basic meaning whereas the vowels inserted reflect additional information such as tense, gender, and number. In (5), for example, the word *qutila* is described as the pattern CuCiCa of the root *qtl*, and this pattern expresses the passive voice of the verb ‘to kill’. Thus, in this traditional analysis, patterns are usually defined in terms of their semantic function, not their morphological structure.

(5)

qatala	'he killed'
qutila	'he was killed'
qattala	'he massacred'
qaatilun	'killer'

(Ratcliffe, 1998)

The morphology of MA is similar to that of CA. That is, words in MA, as in CA, are formed either by concatenative or non-concatenative processes, and the Root-and-patterns approach has also been applied the same way to MA morphology. To give an illustration of how this system was adopted to MA, some patterns of the root *ktb*, which is associated with the concept of “writing”, both in MA, as presented in Harrell (1962), and in CA are shown in (6).

(6)

Classical Arabic	**Moroccan Arabic**	**Gloss**
katab	ktəb	'he wrote'
maktuub	məktub	'written'
kitaab	ktab	'book'
kutub	ktub	'books'
maktaba	mkətba	'writing desk'

2.5. Gender and Number in Moroccan Arabic

2.5.1. Gender in Moroccan Arabic

In MA, all nouns must either be masculine and feminine, i.e., there is no neuter gender. Nouns that do not naturally belong to one of the two genders have grammatical (arbitrary) gender. Most masculine nouns are unmarked, while the majority of feminine nouns are marked by the suffixation of the morpheme *-a*. There are, however, a small number of cases in which masculine nouns are marked by the suffixation of the morpheme *-i* and some cases where feminine nouns are unmarked. (Feminine gender in these nouns is indicated through agreement). (Table 2) shows examples of each of these cases. This classification of gender in MA plays an important role in the patterning of broken plurals as will be shown in the next section.

Table 2: Classification of MA Nouns in Terms of Gender

Gender		**Examples**	**Gloss**
Masculine	**Unmarked**	raʒəl	'man'
		qəlb	'heart'
		ktab	'book'
		bit	'room'
	Marked	dərri	'boy'
		kursi	'chair'
Feminine	**Marked**	kəlb-a	'dog' (fm)
		rəkba	'knee'
		ħəʒra	'rock'
		ħaʒa	'thing'
	Unmarked	ʃəmʃ	'sun'
		dar	'house'

2.5.2. Moroccan Arabic Plurals

2.5.2.1. Introduction

As in CA and all Arabic dialects, MA has two plural types: sound and broken. Sound plurals are formed by the addition of a suffix at the end of the stem, while broken plurals are formed by an internal change in the stem. In other words, sound plural formation is a concatenative process, while broken plural formation is a non-concatenative process. What makes plurals in MA interesting to study is their complexity; that is, it is often not possible to predict which type of plurals a singular word takes based on the surface form of the singular. What is more, some singulars can have both a sound plural and broken plural. It should also be noted that, as in CA, MA is known for number agreement between nouns and adjectives. That is, adjectives are also marked for number; they are treated the same way as nouns when forming their broken plural counterparts. Although most adjectives have sound plurals, there are many adjectives that have broken plurals as will be shown in the data in section 2.5.2.3. CA and MA differ regarding the fact that CA is known for the dual morpheme. The latter is lost in MA due to the influence of Berber which lacks this property. This section will present data of both sound and broken plurals in MA. The second subsection will be devoted to sound plurals; it will present the different suffixes singular words take to form their corresponding sound plurals. The third subsection will present broken plural patterns in MA. These patterns will be divided into major and minor patterns based on their frequency of occurrence.

2.5.2.2. Sound Plurals

Sound plurals in MA are formed through suffixation. There are three sound plural morphemes (suffixes) in MA: *-in*, *-a*, and *-(a)t*. Harrell (1962) introduces 11 categories of singular words whose plural forms end in *-in* including participles, all nisba[2] adjectives and some nisba nouns, all diminutive adjectives, ordinal numbers, adjectives with certain root patterns in the singular, and a few adjectives and nouns with no common root patterns in the singular. Examples of each of these forms presented in Harrell (1962) are summarized in (Table 3):

a. The plural suffix *-in*

Table 3: Harrell's Classification of MA Sound Plurals Ending in -in

	Singular	**Plural**	**Gloss**
Participles	məDRub	məDRubin	'having been beaten'
	katb	katbin	'having written'
	nasi	nasyin	'having forgotten'
All Nisba Adjectives and Some Nisba Nouns	nəfsi	nəfsiyin	'self-respecting'
	nqi	nqiyin	'clean'
	ʒanubi	ʒanubiyin	'southern'
All Diminutive Adjectives	SɣiwəR	SɣiwRin	'little, small'
	zwiwən	zwiwənin	'nice, pretty'
The Ordinal Numerals	talət	taltin	'third'
	ləwəl	ləwlin	'first'
Other Adjective Patterns	ħəʃman	ħəʃmanin	'shy'
	Təmmaʕ	TəmmaʕinTəmmaʕin	'envious'
	məbrad	məbradin	'cold-natured'
	RfiʕRfiʕin	RfiʕinRfiʕin	'good, excellent'
	mijjət	mijjtin	'dead'
Non-Patterned	mərr	mərrin	'bitter'
	rʒəl	rəʒlin	'foot, leg'

[2] Nisba nouns are nouns that designate a profession or an origin of a person. Such nouns are formed by adding the suffix *-i*.

b. The plural suffix *-a*

As Harrell stated, singular words whose plural forms end in *-a* are fewer than those with *-in*. these words include nouns with the root patterns of professional or habitual activities and one four-consonant root pattern. Examples of each of these forms presented in Harrell (1962) are summarized in (Table 4).

Table 4: Harrell's Classification of MA Sound Plurals Ending in -a

	Singular	**Plural**	**Gloss**
Nouns with the root patterns of professional or habitual activities	bənnaj	bənnaja	'mason'
	bəqqal	bəqqala	'grocer'
	kəddab	kəddaba	'liar'
Nouns Ending in -i and referring to professional or habitual activity	bnadri	bnadrija[3]	'tambourine player'
	flajki	flajkija	'boatman'
The quadrilateral noun pattern CəCCaC	SəmSaR	SəmSaRa	'broker, agent, go-between' (in a business transaction)

c. The plural suffix *-a(t)*

Singular words whose plural forms end in *-(a)t* are nouns; this include all diminutive forms, all nouns of unity which are derived from their collective counterparts, nearly all nouns ending in the suffix *-ija*, nearly all nouns of a certain root pattern that refer to human females, feminine participles when used as nouns, nearly all nouns that end in *-u*, and many other nouns with certain root patterns. Examples of each of these forms presented in Harrell (1962) are summarized in (Table 5).

[3] Note that the glide at the end of the stem in sound plurals like *bnadrija* and *flajkija* is inserted to avoid a vowel haitus.

Table 5: Harrell's Classification of MA Sound Plurals Ending in -a(t)

	Singular	**Plural**	**Gloss**
All Diminutive Nouns	bnita	bnitat	'little girl'
	jdida	jdidat	'little hand'
All Nouns of Unity from Collectives	BiDa	BiDat	'egg'
	BəRquqa	BəRquqat	'plum'
	xuxa	xuxat	'peach'
Almost All Nouns Ending in *-ija*	fuqija	fuqijat	type of garment
	ʃəxSija	ʃəxSijat	'personality'
Almost All Nouns of the CeCCaCa Pattern Referring to Human Females	dəllala	dəllalat	'woman auctioneer'
	xəbbaza	xəbbazat	'woman baker'
Sex-Gender Pairs	malika	malikat	'queen'
	xRufa	xRufat	'lamb' (female)
The Nouns of Instance CəCCa and təCCiCa	kədba	kədbat	'lie, falsehood'
	təsriba	təsribat	'Sock'
All nouns of the Patterns mCaCCa, muCaCaCa, tCeCya, and tCeCCiCa	mdabza	mdabzat	'quarrel'
	muDahaRa	muDahaRat	'(political) demonstration'
	tʕəzja	tʕəzjat	'condolence'
	tbəhdila	tbəhdilat	'humiliation'
Almost all Feminine Participles Used as Nouns	mətʕellma	mətʕellmat	'maid servant'
	mərfuda	mərfudat	'vow'
Most Nouns Ending in *-u*	biru	biruwat	'office'
	gaRRu	gaRRuwat	'Cigaret'
Most Nouns on the Pattern of CCa:	Sla	Slawat	'prayer'
	Dwa	dwajat	'medicine'
Many Loan Words	tilifun	tilifunat	'telephone'

2.5.2.3. Broken Plurals

Harrell (1962) states that there are up to 40 broken plural patterns in MA. These patterns vary in use; that is, some patterns may occur more often than others. He introduced 20 broken plural patterns, which he believes to be the most common. According to Al Ghadi (1990), MA broken plural patterns are of two types: major and minor. The major patterns are considered the most productive and commonly used broken plural patterns in MA (10 of the 20 patterns that are considered common according to Harrel), while the minor patterns are less frequent.

a. Major Broken Plural Patterns

The major broken plural patterns in MA are the most common way of pluralization in the language[4]. They can be considered the regular broken plural patterns since, in addition to being very productive, they are used to derive plurals of newly coined words in the language. Examples of these major broken plural patterns are shown in (Table 6).

Table 6: The Major Broken Plural Patterns in Moroccan Arabic

Broken Plural Patterns	Singular	Plural	Gloss
CCVCəC	fəndəq	fnadəq	'hotel'
	xatəm	xwatəm	'ring'
	BlaSa	BlajS	'place'
	saʕa	swajʕ	'hour'
CCVC	bənt	Bnat	'girl, daughter'
	bʕid	bʕad	'far, distant'
	ʒməl	ʒmal	'camel'
	bir	bjar	'well'
CCVCi	ʒərda	ʒradi	'garden'
	rəkba	rkabi	'knee'
	saqja	swaɋi	'irrigation ditch, canal'
	kura	kwari	'ball'

[4] Sound plurals are also very common and used extensively. Most MA words of CA origins and that have sound plurals in CA maintain their sound pluralization. However, MA coined words, words of Berber origins and other French/Spanish borrowed words all undergo broken pluralization. Sound plurals are mainly used to form plurals of borrowed words that have a complex structure to which an internal change cannot be applied.

Based on data from Harrell & Sobelman (1966), Ratcliffe (2002) provides a systematic distribution of these major broken plural patters. The distribution of the broken plural patterns from (Table 6) is shown in (7). The broken plural pattern CCVCəC, for instance, is usually used for singulars with four consonants (fəndəq 'hotel') since, as can be seen in (7a), 99% of four consonantal singular nouns have this broken plural form. It is also used for singulars with three consonants and a full vowel —/a/, /u/, or /i/— (xatəm 'ring'). The broken plural pattern of singulars with three consonantal roots (CCC) or those with two consonants and a full vowel (CVC) is usually the form CCVC (7b). Finally, the broken plural pattern CCVCi (7c) is also used to pluralize CCC and CVC singulars, but only those that have the feminine suffix *-a*. In other words, the observation that can be made with regards to this pattern is that it's used as the broken plural form for the feminine nouns that are marked for gender and that have the forms CəCC-a or CVC-a.

(7)

a. The Broken Plural Pattern CCVCəC

Plural	**Singular**	**Percentage of Occurrence**
CCVCəC	CCCC	99
CwVCəC	CaCC(a)	83
	CaCəC	36
CCVjəC	CCaCa	97
	CCiCa	92
	CCaC	25
	CCiC	21
	CəCCa	13
	CXC	2

b. The Broken Plural Pattern CCVC

Plural	Singular	Percentage of Occurrence
CCaC	CXC[5]	44
	CCiC	44
	CəCCa	9
	CaCəC	7
	CaCCa	6
CCuC	CXC	35
	CCaC	17
	CəCCa	10
	CCaCa	3
	CCiCa	3
	CaCəC	3
CCiC	CCaC	15

c. The Broken Plural Pattern CCVCi

Plural	Singular	Percentage of Occurrence
CCVCi	CəCCa	51
	CCiCa	2

A complication that might affect our observation about the last pattern is the existence of some nouns of the form CəCC-a and CVC-a that have the broken plural form CCaCəC (8). However, in addition to being less frequent, the observation that can be seen regarding the nouns in (8) is the fact that all of them refer to abstract concepts as opposed to the ones that have the broken plural pattern CCVCi which are for the most part concrete nouns.

(8)

Singular	**Plural**	**Gloss**
məħna	mħajən	'ordeal'
fəʕla	fʕajəl	'deed'
Sənʕa	Snayəʕ	'profession'
ʒiha	ʒwayəh	'direction'
saʕa	swajəʕ	'hour'

[5] X can either refer to a consonant (C) or a vowel (V).

In addition to the patterns presented above, there is another productive broken plural pattern that has been emerging in the last two decades (CCuCa). Examples of this pattern are shown in (9). The reason why this pattern should be treated separately is the fact that it's unique since the status of the final *-a* is ambiguous and its origins are unclear (Heath, 1987; Ratcliffe, 2002). Although *-a* is usually a feminine suffix, it hasn't been interpreted as so according to Heath (1987: 111). The addition of this suffix takes place when forming the broken plural of some nouns that would normally have the broken plural pattern CCVC instead of CCuCa (there is no specific meaning associated with this suffix). The ambiguity of this pattern becomes clearer when we examine the broken plurals in (10) which shows that the suffix *-a* is optional in some cases.

(9)

Singular	**Plural**	**Gloss**
kfən	kfuna	'shroud'
dərb	druba	'(dead-end) street'
mqəS	mquSa	'scissors'
fərdi	frada	'pistol'
tali	twala	'last'

(10)

Singular	**Plural**	**Gloss**
ktab	ktub(a)	'book'
xeTT	xTuT(a)	'line'
bit	byut(a)	'room'

b. Minor Broken Plural Patterns

The minor broken plural patterns are considered irregular since they are rarely used and are formed in a very different way from the major patterns. These minor patterns can be subdivided into two categories: those that are heavily influenced by CA either by having a similar prosodic structure to their corresponding CA broken plurals or by having a property that is exclusive to CA, and those that are not used anymore in MA or used only by elders. Examples of these minor broken plural patterns are shown in (Table 7).

Table 7: The Minor Broken Plural Patterns in Moroccan Arabic

Broken Plural Patterns	Singular	Plural	Gloss
CVCCVC	kafər	kuffar	'unbeliever'
	hbil	hubbal	'fool'
CXCan	bab	biban	'door'
	tur	tiran	'bull'
CVCCan, CəCCan	blad	buldan	'country'
	xruf	xərfan	'lamb'
	hri	hərjan	'granary'
CVCəC	BjəD	BujəD	'white'
	qRəʕ	quRəʕ	'afflicted with scalp disease'
CVCVCV	Dʕif	Duʕafa	'poor, measerable'
	rajəs	ruʔasa	'chief, president'
	naħija	nawaħi	'region, environment'
CəCCV	fqi	fəqja	'teacher'
	TBiB	TəBBa	'physician, doctor'
CCVCCV	tunsi	twansa	'Tunisian'
	məɣribi	mɣarba	'Moroccan'

2.5.3. Conclusion

This section was a brief presentation of broken plurals in MA. We have seen that sound plurals can be formed by the suffixation of one of three morphemes: *-in*, *-a*, and *-at*. As for broken plurals, a classification of the different patterns was presented based on their frequency of occurrence. Three broken plural patterns (CCVCeC, CCVC, and CCVCi) were considered to be productive and, thus, called major patterns. Other broken plural patterns were called minor patterns since they occur less frequently.

2.6. Conclusion

This chapter was an overview of MA phonology and morphology, with a focus on data of MA plurals. We have seen that, while MA morphology is, to some extent, similar to that of CA, its phonological system, particularly its vocalic inventory, differs from CA's. As a result, MA syllable structure is significantly different compared to that of CA. This means that any proposed account

of MA broken plural formation that is based on CA broken plural data would have to take into account these differences.

Chapter 3: Review of Literature

3.1. Introduction

Broken Plural formation is one of the most complicated morphological operations in Semitic languages in general and CA in particular. The reason behind this complexity is the fact that this process involves an internal change in the base from which a broken plural word is derived (see section 2.4). Throughout the history of linguistic theory, a number of attempts have been made for the purpose of understanding the behavior of broken plurals both in CA and the dialects of Arabic. This chapter will shed light on the major accounts that have been proposed to deal with this phenomenon.

The second section of this chapter will briefly mention the traditional Root-and-patterns approach to broken plurals in CA. The third section will be devoted to the Prosodic Morphology account of broken plurals; this section is divided into two parts. The first one will discuss McCarthy's (1983) analysis of CA broken plurals using his theory of Non-concatenative Morphology, while the second one will deal with McCarthy & Prince's (1990) Prosodic Circumscription analysis of broken plurals. The fourth section of this chapter will be devoted to McCarthy's (1997) OT analysis of broken plurals in CA, an analysis that is based on Correspondence Theory in OT. The fifth section will discuss the only unified account of MA broken plurals as proposed by Al Ghadi (1990) using Autosegmental Theory.

3.2. Root-and-patterns Approach to Classical Arabic Broken Plurals

Traditionally, the Root-and-patterns approach was used by Arabic grammarians to account for not only verbal morphology, but also nominal morphology. Broken plural formation is one process that has been analyzed using this framework. Wright (1970) identifies more than 30 broken plural patterns or forms in CA (11). Based on their semantic/grammatical content, these forms were classified into different types including but not limited to: 'the plural of the diminutive', 'the plural of multiplication', 'the ultimate plural', and 'the plural of the plural'.

(11)

Type of Broken Plural	**Singular Form**	**Broken Plural Form**	**Gloss**
Plural of the diminutive	riʒl	ʔarʒul	'feet'
Plural of multiplication	kitaab	kutub	'books'
The ultimate plural	ʔiṣba	ʔaṣaabiʕ	'fingers'
Plural of the plural	naadi	nawaadi	'clubs'
Others	naʒm	nuʒuum	'stars'
	ruumi	ruum	'Romans'

(Sakarna, 2012)

The Root-and-patterns analysis was central to the Semitic grammatical tradition as well as European grammars of Semitic languages and was used in comparative descriptions of Semitic languages. However, this analysis is considered outdated and often called a traditional analysis. Ratcliffe (1998) argues that the main problem with this traditional approach is that there are no relations between broken plural patterns on the basis of their forms; broken plural patterns are rather dealt with as isolated forms that are derived from particular roots and have an inherent semantic/grammatical content. This means that broken plurals are derived in more than 30 different manners (i.e. a highly allomorphic system). Therefore, since the 1970s, linguists have been working

on finding ways to account for broken plural formation in CA in a more unified and economical way.

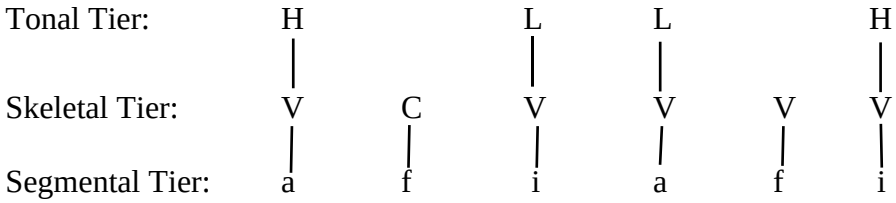
3.3. Prosodic Morphology Analysis of Broken Plurals

In the 1980s, the theory of Prosodic Morphology has been used widely to account for non-concatenative morphological processes in Semitic languages. McCarthy (1983) was the first to apply this theory to broken plural formation in CA. It should be noted that the theory of Prosodic Morphology is based on the framework of Autosegmental phonology (Goldsmith, 1976). Thus, an explanation of the latter is required in order to fully understand how the Prosodic Morphology analysis works.

3.3.1. Autosegmental Phonology

Autosegmental phonology was initially proposed as a revision of the standard Segmental Theory proposed by Chomsky and Halle (1968). It is a non-linear approach to phonology used to describe some features —such as tone, stress, and emphasis— of particular languages that are independent of consonants and vowels and that the Segmental Theory was not able to account for. Autosegmental phonologists claim that phonological representations involve several independent, parallel tiers (levels of representation). One represents vowels and consonants and is called the Segmental Tier, and another represents those independent features (e.g. tone, stress, or emphasis) – in the case of tone languages such as Mandarin, for instance, tones are represented on a tier named the Tonal Tier. These two tiers are linked to each other by association lines which show how they are co-articulated. These lines form a third tier called the Skeletal Tier (or CV tier), as shown in the following model proposed by Steriade et al. (1988).

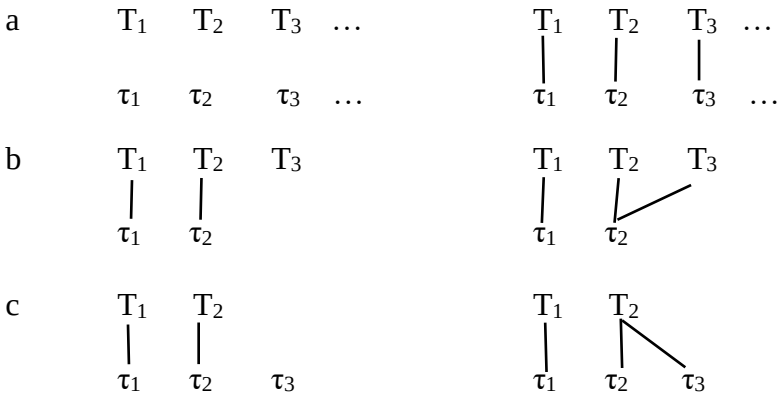
(12)



NB: L and H stand for low and high tone.

In a prosodic representation like (12), the association between levels is not arbitrary; rather, it is ensured by autosegmental principles (Goldsmith, 1976). These principles were put forward by Clements & Ford (1979) in the form of universal conventions for associations between tonal elements (τ) and tone-bearing elements (T) in an autosegmental representation. The main association convention states that each tonal element is associated with a tone-bearing elements in a one-to-one manner from left to right (13a). If there are more tone-bearing element than the existing tonal elements (13b), the same procedure takes place, and then the rightward tonal element reassociates with the remaining tone-bearing element. The same process occurs when there are more tonal elements than tone tone-bearing elements (13c). McCarthy (1981) adopted these conventions and used them in his theory of Non-concatenative Morphology.

(13) Universal Association Conventions



3.3.2. Prosodic Morphology

3.3.2.1. Introduction

The emergence of Autosegmental Phonology (Goldsmith, 1976, 1979) was crucial in the analysis of Non-concatenative Morphology. Through the use of Autosegmental principles, McCarthy (1979, 1981) was able to understand the phenomena of discontinuous affixation in the morphology of Semitic languages like CA. This gave rise to the theory of Non-concatenative Morphology (McCarthy, 1979, 1981, 1982) as well as Prosodic Morphology (McCarthy & Prince, 1986 et seq.).

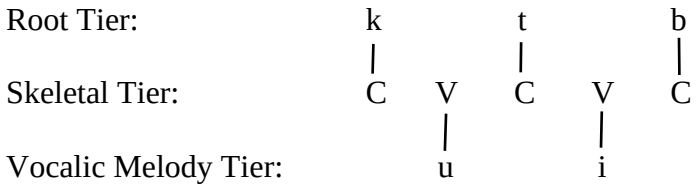
3.3.2.2. The Prosodic Theory of Non-concatenative Morphology

The Prosodic Theory of Non-concatenative Morphology was initiated by McCarthy (1981). The main concept in this theory is the skeleton template[6], which is a morpheme consisting of C and V slots. McCarthy (1979, 1981) argues that, in languages involving non-concatenative morphological processes, morphemes are represented in a non-linear fashion on different levels called tiers. These tiers are linked to the skeleton template. The mapping of these tiers to the template is ensured by a set of autosegmental principles. To give an illustration, at the underlying level of representation in the lexicon, the verb in CA consists of elements arranged on three independent tiers: the Root Tier (or the Consonantal Tier), the Skeletal Tier, and the Vocalic Melody Tier.

[6] This is why McCarthy's theory is often called Templatic Morphology.

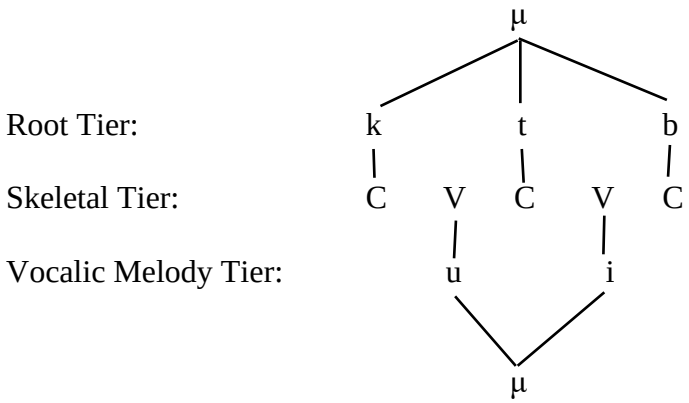
- **The Root Tier** provides the meaning of the verbal lexeme represented by consonantal segments. For example, the root /ʕql/ represents the lexeme 'remember'; /srq/ represents the lexeme 'steal'; and /fʕl/ represents the lexeme 'do'.
- **The Skeletal Tier** is a template. It provides a canonical form of words associated with a particular meaning or grammatical function. For example, the template CVCVCV shown above is associated with the past tense of verbs. So /kataba/ means 'he wrote' and /saraqa/ 'he stole'.
- **The Vocalic Melody Tier** provides information about inflection, which includes tense, aspect, and number morphemes, as well as derivation. For example, the vocalic melody /u_i/ is used in CA to express the passive voice of verbs. As is the case in Autosegmental Phonology, morphological rules in CA convey the grammatical information of words in the form of melodies consisting of one or more vowels that fill different vowel slots on the Skeletal Tier.

(14)



McCarthy (1981) claims that each morpheme in a word is represented in the lexicon in the form of a separate tier, hence the Morpheme Tier Hypothesis. This additional tier is symbolized by *μ*. As can be seen in (15), both the root morpheme */ktb/* and the vowels inserted in the template represent two different morphemes.

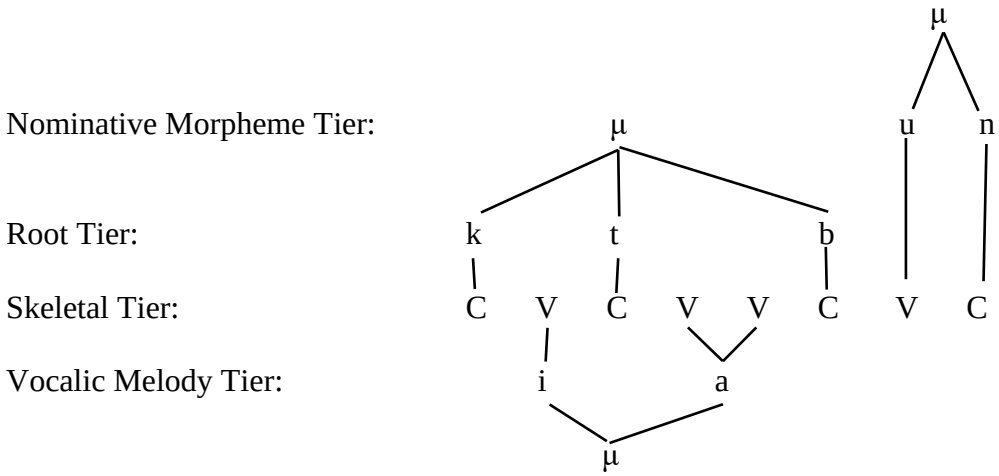
(15)



kutib 'was written'

Note that prefixes and suffixes are also represented on a separate tier; they are considered independent of the root and the vocalic melodies. Some examples from CA include the words /*maktabun/* and /*kitaabun/*. It can be seen from the example in (16) that the suffix *-un* represents a separate tier called the Nominative Morpheme Tier.

(16)



kitaab-un 'book' (nominative)

3.3.2.3. A Prosodic Theory Analysis of Classical Arabic Broken Plurals (McCarthy, 1983)

McCarthy (1983) used the templatic analysis explained in the previous section to account for broken plural formation in CA. His analysis mainly focuses on two major broken plural forms: CVCVVCV(V)C and CVCV(V)C. In what follows, the broken plural formation of the former will be illustrated using McCarthy's (1983) analysis. The broken plural pattern CVCVVCV(V)C is usually used to form the broken plural of quadriliteral roots in CA. (17) shows examples of broken plurals of this pattern.

(17)

Singular	**Plural**	**Gloss**
ʒilbaab	ʒalaabiib	type of garment
ʒundab	ʒanaadib	'locust'
SulTaan	SalaaTiin	'sultan'
miftaaħ	mafaatiiħ	'key'
namuuðaʒ	namaaðiʒ	'type'
ʃajTaan	ʃajaaTiin	'devil'

When observing the behavior of broken plurals of this pattern, McCarthy came up with two main generalizations. First, the vowels of the broken plural forms are consistent; the vowel /i/ is mapped onto the final syllable of the broken plural, while the vowel /a/ is mapped onto the two initial syllables. Second, the vowel length in the final syllable of a broken plural form is identical to that of its corresponding singular form.

Based on these generalizations, two main stipulations were put forward by McCarthy (1983). First, the relationship between singulars and broken plurals in (17) can be drawn based on the syllabification of both. According to McCarthy (1983), in forming the broken plural of a quadriliteral singular form in CA, the insertion rule of a VV sequence is applied after the initial

syllable of the singular form (18). The output of this rule is, then, resyllabified to conform with CA syllable structure.

(18) VV-insertion Rule

Ø --> VV / [σ ___

Second, the broken plural morpheme is a sequence of two vowels (i.e. a vocalic melody). According to McCarthy, three main steps are followed to associate the vowels of the vocalic melody with the vowel slots of the broken plural prosodic template. In the first step, the vowel /i/ is associated with the initial V position of the final syllable of the broken plural template using a special association rule (19a). Then, the vowel /a/ is associated with the remaining vowel slots of the template (19b). Finally, in case there is a second vowel in the final syllable of the broken plural form, the vowel /i/ is associated with that vowel slot (19c). An example of this whole process is seen in (20).

(19)

a. [CVCVVCVVC]

a i

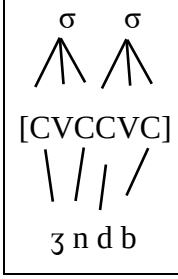
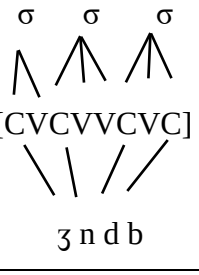
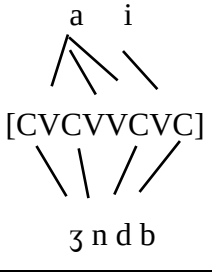
b. [CVCVVCVVC]

a i

c. [CVCVVCVVC]

a i

(20)

Singular	**VV-insertion**	**Resyllabification**	**Output Broken Plural Form**
			

In addition to the nouns in (17), there is a small set of triliteral nouns that has both the same vocalic melody and the same broken plural template of those in (17). Examples of these nouns are shown in (21).

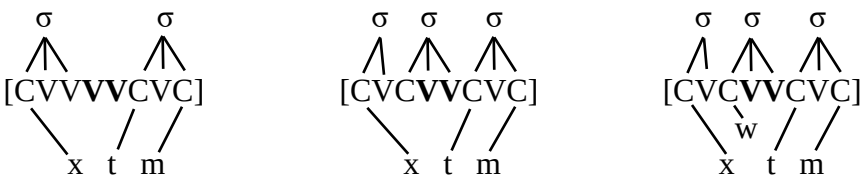
(21)

Singular	**Plural**	**Gloss**
xaatam	xawaatim	'signet ring'
ħaamil	ħawamil	'pregnant'
ʒaamuus	ʒawaamiis	'buffalo'
qanuun	qawaaniin	'rule' or 'law'

What McCarthy (1983) attempts to account for is the additional consonant that is not present in the consonantal root and that appears in the broken plural template. In order to understand where the glide /w/ comes from, let us see how the broken plural forms of the word *xaatam* is formed. First, VV-insertion after the initial syllable takes place (22a). The result of this process does not conform to the CA syllabification because of the sequence of four vowels. Therefore, McCarthy argues that the second vowel changes into a consonant to conform both to the syllable structure of CA and to the broken plural template. This results in the form in (22b). Finally, the new C position is associated with /w/, which is represented on a separate tier according to McCarthy (22c).

(22)

a. **VV-insertion** b. **V to C** c. **w-insertion**



3.3.2.4. Against Root-and-template Analysis of Classical Arabic Broken Plurals

The Prosodic Morphology analysis summarized in the previous sections works perfectly for a number of morphologically derived forms in CA. However, McCarthy & Prince (1990) claim that broken plurals are formed from their corresponding singular forms, not from their underlying roots. Their rejection of a Root-and-template analysis stems from the idea that the singular and plural forms in CA share a number of features that are not present in the underlying root. One of the features that are transferred from the singular to the plural is the vowel length of the final-syllable in some broken plural patterns of CA as can be seen in (23).

(23)

	Root	**Singular**	**Plural**	**Gloss**
a.	/jndb/	ʒun.dab	ʒa.naa.dib	'locust'
	/slTn/	sul.Taan	sa.laa.Tiin	'sultan'
b.	/ʒms/	ʒaa.muus	ʒa.waa.miis	'buffalo'
	/xtm/	xaa.tam	xa.waa.tim	'ring'

Another main argument in favor of singuar-to-plural analysis of CA broken plurals concerns triconsonantal singular forms with long vowels; these cases usually involve glide insertion in the broken plural form. The position of the glide in these broken plural forms depends on the position of the long vowel in the singular forms as shown in (24). If the long vowel is in the first syllable of the singular as in (24a), the glide takes the position of the onset of the second syllable of the broken

plural form; if the long vowel is in the second syllable of the singular as in (24)(24b), the glide takes the position of the onset of the last syllable of the broken plural form.

(24)

	Root	Singular	Plural	Gloss
a.	/ʒms/	ʒaamuus	ʒawaamiis	'buffalo'
	/xtm/	xaatam	xawaatim	'ring'
b.	/sħb/	Saħaab + at	saħaawib	'cloud'

In short, these arguments show that broken plural forms in CA should be formed from their corresponding singular forms, not from the underlying roots since the latter does not show important information that are transferred from singular to broken plural forms. McCarthy & Prince (1990), then, suggest that a word-to-template mapping should be used to account for this phenomenon.

3.3.2.5. A Revised Prosodic Morphology Analysis of Classical Arabic Broken Plurals (McCarthy & Prince, 1990)

3.3.2.5.1. Introduction

McCarthy & Prince (1986) developed a revised Prosodic Morphology account of word formation in CA. They argue against templates that operate with CV units. Rather, they argue that Non-concatenative Morphology can be better analyzed using prosodic templates, i.e. those that operate with units of prosody. According to McCarthy and Prince, the existence of prosodic templates is motivated by the fact that they are made up of prosodic units that are independently necessary, which is not the case in the traditional CV-templatic approach. Thus, according to McCarthy and Prince, morphological representations should be mapped directly onto the different

prosodic units including the mora, the syllable, the foot, and the prosodic word. This theory is based on the following fundamental hypotheses:

> **a) Prosodic Morphology Hypothesis**: Templates are defined in terms of authentic units of prosody: mora (μ), syllable (σ), foot (Ft), prosodic word (PWd), and so on.
> **b) Template Satisfaction Condition**: Satisfaction of templatic constraints is obligatory and is determined by the principles of prosody, both universal and language-specific.
> **c) Prosodic Circumscription of Domains**: The domain to which morphological operations apply may be circumscribed by prosodic criteria as well as by the more familiar morphological ones. In particular, the minimal word within a domain may be selected as the locus of morphological transformation in lieu of the whole domain.
>
> McCarthy & Prince (1990, pp. 209-210)

3.3.2.5.2. Prosodic Circumscription

What is of importance to the analysis of CA broken plurals is Prosodic (or Operational) Circumscription. The main idea behind the latter is that there are certain phenomena in which a morphological operation is applied only to a particular prosodic constituent in the base, not to all of it. Prosodic Circumscription, as viewed by McCarthy & Prince (1990), offers a new view to the problem of broken plural formation in CA. McCarthy & Prince (1990) suggest that broken plurals are formed by a special kind of suffixation. The base that the broken plural suffix is attached to, according to McCarthy and Prince, is a part of the singular word, more specifically the initial minimal word or heavy syllable (CVC or CVV), which is equivalent to two moras. According to McCarthy & Prince (1990), in forming the broken plural of quadriliteral roots in CA, several steps are to be followed:

i. The first two moras, which are equivalent to a minimal word in CA, are mapped onto the broken plural template which is equivalent to an iambic foot, i.e. a sequence of light-heavy syllables (CVCVV).

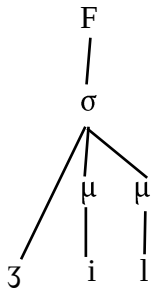
ii. The vowel of the first mora spreads through the iambic foot of the template, while the first two onsets are filled in by the two consonants of the first two moras.

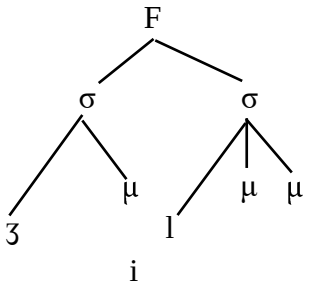
iii. The first vowel of the vocal melody [a_i] is associated with the template of the first iambic foot.

iv. The remainder of the singular form is added, and the vowel of the singular form will be replaced by the second vowel of the vocal melody.

To illustrate how this theory works, let us take one of the most productive broken plural patterns in CA. Examples of this pattern are shown in (17) above. The plural form of the word *ʒilbaab* 'type of garment', for example, is *ʒalaabiib*. The initial minimal word in the singular form is *ʒil* (25a). As the first step says, the contents of the circumscribed portion are mapped onto the broken plural template CVCVV (i.e. the iambic foot) as in (25b).

(25)

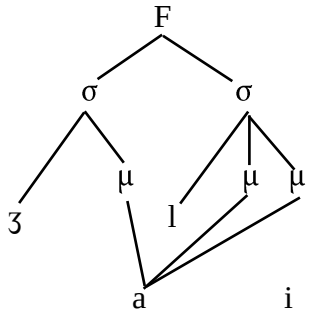
a. 

b. 

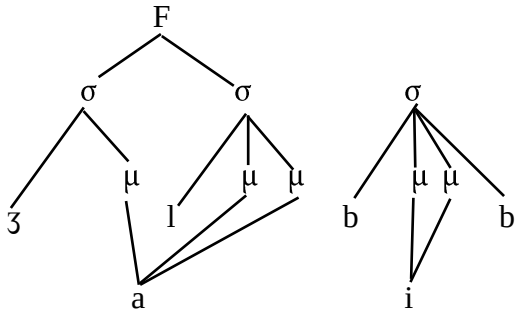
After mapping the consonants of the circumscribed portion onto the broken plural template, the vowel /*i*/ from the first mora of *ʒilbaab* is replaced by the vowel [a] of the vocal melody as shown in (26a). Finally, the rest of the singular form (i.e. baab) is attached to the iambic template, and the second vowel of the vocal melody /a_i/ is associated as in (26b).

(26)

a.



b.



In addition to examples like (17), McCarthy & Prince (1990) also account for the words in (21) that involve w-insertion. According to McCarthy and Prince, the insertion takes place in order to fill the onset position of the second syllable in the broken plural template (CV**C**VV) since the circumscribed portion of the singular form has only one consonant as the examples in (27) show.

(27)

Singular	**Circumscribed Portion**	**Broken Plural Template**	**Gloss**
xaatam	xaa	xawaa	'ring'
ʒaamuus	ʒaa	ʒawaa	'buffalo'

3.3.3. Problems of Prosodic Circumscription as an Analysis for Broken Plurals

The theory proposed by McCarthy & Prince (1990) accounts to a certain extent for some major broken plural patterns of CA. However, the theory is unsatisfactory for accounting for the broken plurals in MA because the latter is different from CA in both its vocalic inventory and its prosody. In MA, several patterns of the broken plural can be accounted for following the same steps mentioned in the previous section except for two main differences (Nirheche, 2019). The first is that, in MA, the broken plural template which the minimal word is mapped onto is CCV. Second, after considering the structure of these patterns and their singular counterparts, it can be said that

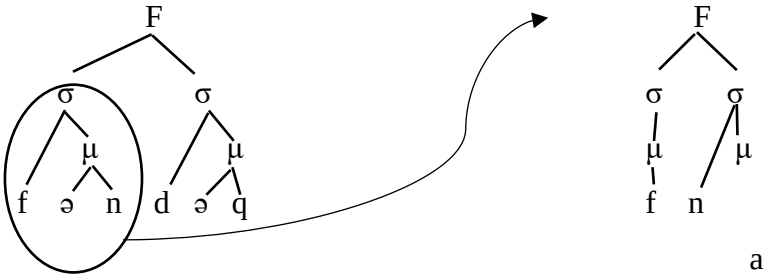
it is the initial minimal syllable (CV or CəC) of the singular word not the initial minimal word which is mapped onto the broken plural template. These differences can be seen in (28).

(28)

	Classical Arabic			**Moroccan Arabic**		
Singular	**Broken Plural Template**	**Plural**	**Singular**	**Broken Plural Template**	**Plural**	**Gloss**
funduq	fanaa	fanaadiq	**fən**dəq	fna	fnadəq	'hotel'
xaatam	xawaa	xawaatim	**xa**təm	xwa	xwatəm	'ring'
qalb	quluu	quluub	**qəl**b	qlu	qlub	'heart'

To give an illustration of how this system can be applied to MA, let us take an example of how a four-consonantal noun of the broken plural pattern CCVCəC in MA is formed. First, the initial minimal syllable of the singular form –in this case CəC– is mapped onto the plural template CCV as seen in (29). The vowel [a] of the vocal melody is then associated with the template of the first iamb (30a). Finally, the remainder of the singular form is then added (30b).

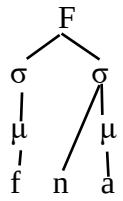
(29)



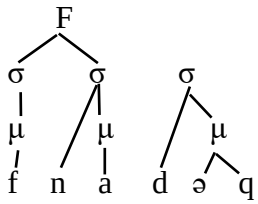
a

(30)

a.



b.



Although the Prosodic Circumscription analysis adopted from McCarthy & Prince (1990) seems to work perfectly for the broken plural pattern CCVCəC, with the modifications for MA outlined above, there are a number of examples for which this analysis cannot work. One main

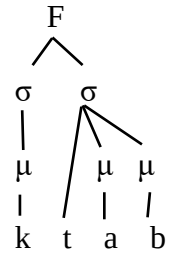
assumption of McCarthy and Prince's analysis is that the weight of the final syllable of the singular forms is preserved when forming broken plurals of CA. In MA, however, this is not always the case since there are a number of four consonantal nouns of the broken plural pattern CCVCəC that do not exhibit this preservation of weight, as can be seen in the examples in (31). In this case, the last step of forming broken plurals using Prosodic Circumscription —attaching the remainder of the singular form to the broken plural template CCV— would not work for these examples.

(31)

Singular	**Broken Plural**	**Gloss**
məs.**ki$^{\mu}$n$^{\mu}$**	msa.**kən$^{\mu}$**	'a poor person'
Təb.Si$^{\mu}$l$^{\mu}$	Tba.**Səl$^{\mu}$**	'pot'

As in the broken plural pattern CCVCəC, Prosodic Circumscription can similarly work for the productive triconsonantal broken plural pattern CCVC. In forming the broken plural of a word like *bənt*, for instance, the consonants /b/ and /n/ of the initial minimal syllable *bən* are mapped onto the template CCV (*bn*V). Then, the vowel /a/ is associated with the template and the remainder of the singular form (/*t*/) is added to the template. This produces the broken plural form *bnat*. Although this analysis works for a number of examples of the broken plural pattern CCVC, any singular form that does not begin with a minimal syllable (CV or CəC) cannot be analyzed using Prosodic Circumscription. This is the case in many singular forms of the broken plural pattern CCVC including the forms CVC, CVCəC, and CCVC. For example, the singular word *ktab* ('book'), whose broken plural form is *ktub*, begins with a degenerate syllable *k*, not a minimal syllable, as seen in (32).

(32)



If we apply Prosodic Circumscription to the example in (32), we would have to parse out the initial minimal syllable (CəC or CV), which is the first step in forming broken plurals using Prosodic Circumscription. The word *ktab*, however, does not begin with a minimal syllable (it begins with a degenerate syllable). Forming the broken plural of this word can only work if we parse out the sequence *kt*, map it onto the broken plural template CCV to give us the form *ktu*, and, then, attach the remainder of the singular form, i.e. *b*, to derive the broken plural surface form *ktub*. This would be a violation of the main assumption of Prosodic Circumscription since the sequence *kt* is not a constituent as *k* and *t* belong to different syllables as can be seen in (32). Therefore, the circumscriptional analysis proposed above cannot be applied to this example.

3.4. Optimality-Theory Analysis of Classical Arabic Broken Plurals

3.4.1. Against the Circumscription Analysis in Classical Arabic

McCarthy (1997) proposed an OT analysis of some of the phenomena involving infixation that had been analyzed using Prosodic Morphology, one of which is CA broken plural formation. This analysis is proposed as an alternative to his previous account of this phenomenon using the

theory of Prosodic Circumscription (McCarthy & Prince, 1990). McCarthy (1997) argues against the latter by providing some cases in which there is no initial prosodic constituent that is parsed out form the singular form. As discussed above, this prosodic constituent is a heavy syllable (equivalent to two moras). McCarthy claims that there are a number of broken plural forms whose singulars begin with a light syllable. The word *jaziir*, for instance, begins with an iambic foot, a fact which is not considered when applying Prosodic Circumscription, resulting in the splitting of a syllable (the circumscribed portion=*jazi*); this is similar to the problem of the MA example in (32) where forming the broken plural of the word *ktab* results in parsing out a sequence of segments that is not a constituent except that , in that case, the segments belong to two different syllables. McCarthy (1997) argues that these circumscriptional systems can be dealt with in a more explanatory fashion using OT. He stresses that Prosodic Circumscription should not be a part of linguistic theory. In his view, using a set of independently motivated markedness and faithfulness constraints is better than applying a series of ordered operations.

3.4.2. Output-output Correspondence Theory as an Analysis of Classical Arabic Broken Plurals (McCarthy, 1997)

3.4.2.1. Output-output Correspondence Theory

McCarthy's (1997) OT analysis relies on Output-output Correspondence Theory. Correspondence refers to the relationship that holds between the features, segments, and prosodic units of two morphologically related forms. Correspondence theory (McCarthy & Prince, 1995) was originally used to account for the relationship between a base and a reduplicant in morphological processes that involve reduplication. Later, the theory was also used to account for

input-output faithfulness. Correspondence was also extended to account for the relation between a base and derived output form, hence, the term Output-output Correspondence (Basri et al., 1998; Benua, 1995, 1997; Burzio, 1996; Kager, 1996; Kenstowicz, 1996, 1997; McCarthy, 1995; McCarthy, 1997; Selkirk, 1999; among others). McCarthy & Prince (1995) formally defined correspondence as follows:

(33) Correspondence

> pluralGiven two strings S1 and S2, correspondence is a relation $\mathcal{R}$ from the elements of S1 to those of S2. Elements $\alpha \in$ S1 and $\beta \in$ S2 are referred to as correspondents of one another when $\alpha \mathcal{R} \beta$.
>
> McCarthy & Prince (1995: 15)

3.4.2.2. Output-output Correspondence Account of Classical Arabic Broken Plurals

McCarthy (2000) claims that, in CA, broken plurals are derived from their corresponding singular forms and that this process should be accounted for using Output-output Correspondence Theory. More specifically, broken plural formation in CA, according to McCarthy, can be analyzed in terms of output-output prosodic faithfulness constraints in OT (Alderete, 1995, 1996; Beckman, 1997; Burzio, 1994a, 1994b; Bye, 1996; Itô et al., 1996; Kenstowicz, 1994, 1996; McCarthy, 1995; Pater, 1995).

McCarthy (2000) proposes three assumptions as far as prosodic faithfulness is concerned. First, the linguistic elements related by the correspondence relation, as defined in (33), are prosodic units. In CA broken plurals, these elements are primarily moras. Second, the type of the correspondence relation through which the two linguistic forms are related can be an IO, BR, or OO faithfulness relation. Since McCarthy claims that broken plurals in CA are derived from their singulars, the faithfulness relation is between two output forms. Third, prosodic faithfulness can be

ensured by a number of constraint types including anti-insertion and anti-deletion constraints, constraints demanding conservation of autosegmental associations, constraints demanding conservation of prosodic constituents, and constraints demanding faithfulness to the edges or heads of prosodic constituents. As for broken plural formation in CA, only the first two types of constraints are needed according to McCarthy (1997).

In analyzing broken plurals in CA, McCarthy focuses on the relation between the prosodic structure of both singulars and broken plurals. This new analysis of broken plurals in CA is based on two main observations:

i. The weight of the final syllable of the singular form always stays the same in the broken plural form[7] as can be seen in (34).

(34)

Singular	**Plural**	**Structure of the Final Syllable**
ʒil.**baab**	ʒalaa.**biib**	$CV^{\mu}V^{\mu}C^{\mu}$
ʒun.**dab**	ʒanaa.**dib**	$CV^{\mu}C^{\mu}$
Sul.**Taan**	Salaa.**Tiin**	$CV^{\mu}V^{\mu}C^{\mu}$
xaa.**tam**	xawaa.**tim**	$CV^{\mu}C^{\mu}$

ii. A mora is always added to the second syllable of the broken plural form as opposed to its singular. This can be seen in the examples in (35).

(35)

Singular	**Plural**	**Gloss**
ʒundub	ʒanaadib	'locust'
sulTaan	salaaTiin	'Sultan'
xaatam	xawaatim	'ring'

[7] This observation was also discussed in relation to McCarthy's templatic analysis in section 3.3.2.4.

McCarthy claims that an analysis of these observations can be accounted for through prosodic faithfulness constraints in OT. Preserving the weight of the final syllable, for instance, is a consequence of a high-ranking of MAX$_{00}$-μ and DEP$_{00}$-μ.

- **MAX$_{00}$-μ**: do not delete a mora in the output plural.
- **DEP$_{00}$-μ**: do not insert a mora in the output plural.

Concerning the second observation, McCarthy suggests that the added μ can be considered a suffix that is forced to be in an infix position due to some high-ranking positional faithfulness constraints similar to the ones proposed by Beckman (1995, 1997). Some of these might include constraints like **ANCHOR-POS** and **ANCHOR-SEG**. The former is used to preserve a segment's position under correspondence, while the latter preserves the segment itself standing in its designated position. Positional faithfulness constraints like these can be used to account for the position of the added mora in CA broken plurals, according to McCarthy. However, McCarthy does not propose any particular positional faithfulness constraints or illustrate how this aspect of the analysis works.

McCarthy argues that the OT analysis will also deal with the distribution of epenthetic consonants in some broken plural forms. Let us give an illustration of this issue. In *xaatam/xawaatim*, the circumscribed portion is *xaa*, i.e. it contains only one consonant, so the epenthetic consonant /w/ appears in the iambic broken plural template (*xa**w**aa*). In *saħaab+at/saħaaʔib*, the circumscribed portion is *saħa*, i.e. it contains two consonants, so the epenthetic consonant /ʔ/ appears in the final syllable of the broken plural form (*ʔ**i**b*). Regarding this issue, McCarthy suggests that moras and segments are in correspondence, and that the distribution of consonant epenthesis is an effect of preserving corresponding segment-to-mora linkage. This can be accounted for using anti-spreading and anti-delinking faithfulness constraints: **NO-DELINK(μ, SEG)** and **NO-SPREAD (μ, SEG)**. These constraints are used to preserve segment-to-mora

linkage in the singular-plural mapping so that if a segment is associated with a particular mora in the singular form, that segment should be associated with the same mora in the broken plural form. Being undominated, these constraints will ensure that the output for singulars like *xaatam* is *xawaatim*, not **xataawim*.

McCarthy (1997)'s OT analysis of broken plural formation in CA is certainly not a complete one. First, he does not propose any positional faithfulness constraints to deal with the issue of the added mora. Second, he does not provide any partial or combined ranking of the constraints he proposes. Later, this analysis has been developed in more detail by Al Aghbari (2012) to account for broken plural formation in the Muscat dialect of Omani Arabic. Al Aghbari (2012) claims that the proposal made by McCarthy (1997) about the difference in the prosodic structure between singulars and broken plurals in CA –the affixed mora– is also true in Muscat Arabic. To analyze the broken plural data, Al-Aghbari proposed a full OO-Correspondence analysis that is based on the assumptions made by McCarthy (1997). In this analysis, Al-Aghbari makes use of both syllabic well-formedness as well as faithfulness constraints that require identity between singulars and broken plurals of Muscat Arabic. For the former, he suggests constraints like **ONSET** and **UNEVEN-IAMB**. As for the latter, he makes use of MAX$_{OO}$-μ and DEP$_{OO}$-μ proposed by McCarthy (1997).

3.4.3. Problems of Output-output Correspondence as an Account of Moroccan Arabic Broken Plurals

Although McCarthy's OT analysis is a promising proposal for future research in the field of Arabic morphophonology, the generalizations he made are not true for all the relevant MA

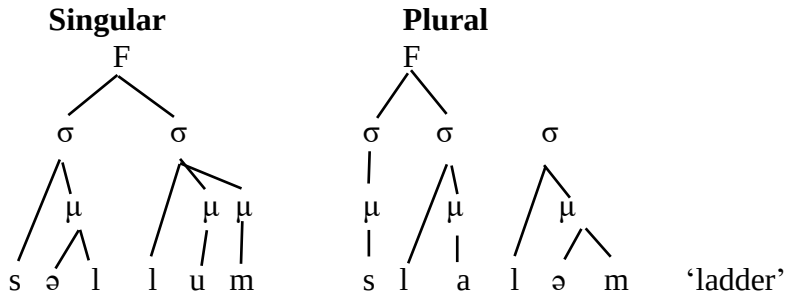
broken plural patterns. Firstly, the weight of the final syllable of the singular forms is not always preserved in MA four consonantal root nouns as can be seen in the examples in (36). Secondly, although there generally is an added mora between the singular and broken plural forms in MA, there are some cases in which there is no added mora as can be seen in (36). Therefore, it can be clearly seen that the Output-output Correspondence analysis proposed by McCarthy cannot, as it is, be applied on MA broken plurals.

(36)

a.

Singular	**Broken Plural**	**Gloss**
məs.**ki**$^{\mu}$**n**$^{\mu}$	msa.**kən**$^{\mu}$	'a poor person'
Təb.**Si**$^{\mu}$**l**$^{\mu}$	Tba.**Səl**$^{\mu}$	'pot'

b.



3.5. Autosegmental Theory as an Analysis of Moroccan Arabic Broken Plurals

As we have seen in the previous sections, a number of theoretical frameworks have been proposed to account for broken plural formation in CA. This, however, is not the case when it comes to MA since only one unified analysis has been proposed to account for broken plural formation in MA, i.e. that by Al Ghadi (1990) who proposes an analysis of MA broken plurals based on Autosegmental Theory. For Al Ghadi, there are three important elements in broken plural formation in MA: the root, the stem, and the word. Broken plurals in MA are derived from their

corresponding underlying roots by the insertion of an element into the nominal root at an initial stage, whereas syllabification takes place at a later stage. Al Ghadi argues that broken plurals cannot be derived from their corresponding singular forms because, in many cases, there are elements (mostly vowels) in the singular form that are not present in the broken plural (37a) and other elements that get replaced when forming the broken plural (37b); he says that this leaves us with the unnecessary task of accounting for these deleted and replaced elements (Al Ghadi, 1990, p. 97). Taking a root-based approach, however, is much simpler, according to him, since it would reduce the pluralization process to a simple insertion of an element. Therefore, Al Ghadi claims that both singulars and broken plurals are derived from the underlying nominal root.

(37)

	Singular	**Plural**	**Gloss**
a.	r**a**jəl	rjal	'hotel'
	məsk**i**n	msakən	'poor'
b.	kt**a**b	kt**u**b	'trick'
	ql**a**m	ql**u**m	'ring'

3.5.1. Al Ghadi's Conception of Moroccan Arabic Nominal Roots

According to Al Ghadi (1990), nominal roots in MA are different from CA roots. While nominal roots in CA are purely consonantal, Al Ghadi argues that, beside consonantal roots, nominal roots in MA can also contain vowels. According to him, the vowels that are part of a nominal root are those that are stable across different derived forms. For instance, (38) shows that the vowel /i/ in the noun giTun ('tent') must be in the root since it is present in all the possible forms derived from the same root, while the vowel /u/ is not part of the root since it is present only in the singular form. In the noun məskin ('poor'), the vowel /i/ is not present in the root since it does not show up in other morphologically derived forms (39).

(38)

Root	/gitn/	
Singular Noun	g**i**Tun	'tent'
Verb	g**i**Tən	'to tent'
Adjective	mg**i**Tən	'staying in a tent'
Broken Plural	gjaTən	'tents'

(39)

Root	/mskn/	
Singular Noun	məskin	'poor'
Verb	Tməskən	'to pretend to be poor'
Adjective	mməskən	'pretending to be poor '
Broken Plural	msakən	'poor people'

In this way, we can also account for the existence of glides in some broken plural forms of MA such as the word in (38). The presence and choice of the glide that show up in these broken plural forms depend on a particular vowel in their corresponding singular form. (40), for instance, shows that, if the vowel in the singular is /a/ or /u/, the epenthesized glide in the broken plural is /w/; if the vowel is /i/, /j/ is inserted.

(40)

Singular	**Plural**	**Gloss**
qaləb	qwaləb	'trick'
giTun	gjaTən	'tent'

Al Ghadi claims that these singular vowels are also present in MA nominal roots. To conclude, MA, according to Al Ghadi, has two main kinds of roots: quadrisegmental and trisegmental roots. Both of these can either have a vowel (41b) and (42b) or be entirely consonantal (41a) and (42a).

(41)

	Root	**Plural**	**Gloss**
a.	fndq	fnadəq	'hotel'
	mskn	msakən	'poor'
b.	qalb	qwaləb	'trick'
	xatm	xwatəm	'ring'

(42)

	Root	Plural	Gloss
a.	bnt	bnat	'girl'
	ʒml	ʒmal	'camel'
b.	bir	bjar	'well'
	Sur	Swar	'wall'

3.5.2. Al Ghadi's Analysis of Broken Plural Formation in Moroccan Arabic

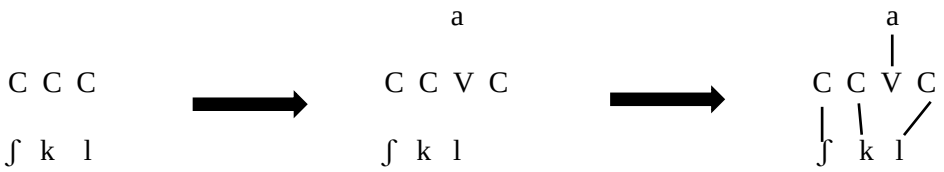
Broken plural formation in MA is understudied, compared to CA; very few attempts have been made to investigate this phenomenon in MA (Al Ghadi, 1990; Lahrouchi & Ridouane, 2016; and Noamane, 2018). Lahrouchi & Ridouane's (2016) focus was on nouns that have both sound and broken plurals from a syntactic perspective. Noamane's (2018) focus was on geminates in MA from an OT perspective; although he uses broken plural data (those that contain geminates), his aim was to understand the behavior of geminates in MA, not to provide an analysis of broken plural formation. Al Ghadi's (1990) is the only unified account of MA broken pluralization. His analysis of MA broken plurals is based on Autosegmental Theory. According to Al Ghadi, both templates and autosegmental associations are necessary to account for broken plural formation in MA. Broken plural formation is a process of inserting different C/V slots into the root resulting in different broken plural patterns (i.e. templates), and then the surface broken plural form is produced after syllabification. According to Al Ghadi, there are five root shapes in MA: CCC, CVC, CCV, CCCC, CVCC. 10 different broken plural Patterns are derived from these roots. The inserted slots that show up in the surface broken plural forms in MA are of three shapes: V, CV, or VC[8]. To give an illustration of how this process works, let us consider some examples from the most productive

[8] It should be pointed out that the broken plural patterns that are derived from the same root can have different inserted elements (V, CV, or VC).

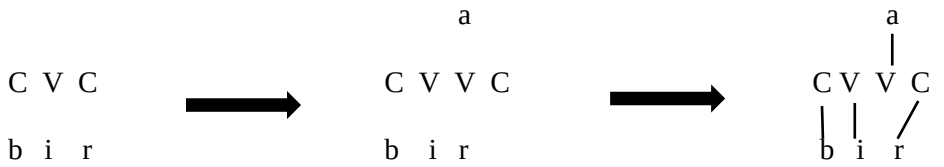
broken plural patterns in MA: CCVC and CCVCəC. For the former, the broken plural formation of the nouns *ʃkəl* (‘form’) and *bir* (‘well’) that are derived from the trisegmental roots CCC and CVC, respectively, are illustrated in (43).

(43) Insertion of the Broken Plural Morpheme *-a*

a.



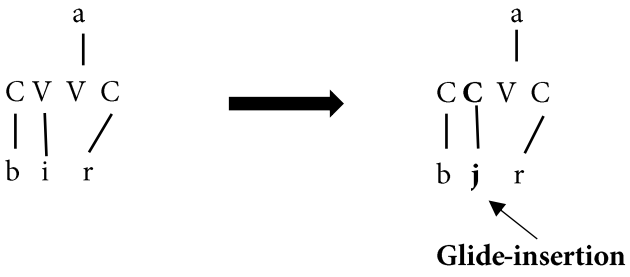
b.



(Al Ghadi, 1990, pp. 132-133)

According to Al Ghadi, (43) is the first stage of broken plural formation in MA; at this stage, the broken plural morpheme —in this case *-a*— is inserted after the second segment of the root. Syllabification occurs at a later stage. In (43b), the vowel /i/ is replaced by the glide /j/ (44) to avoid having two adjacent vowels, which is prohibited in MA. This gives us the surface form *bjar* (‘wells’).

(44) Syllabification: Glide-insertion

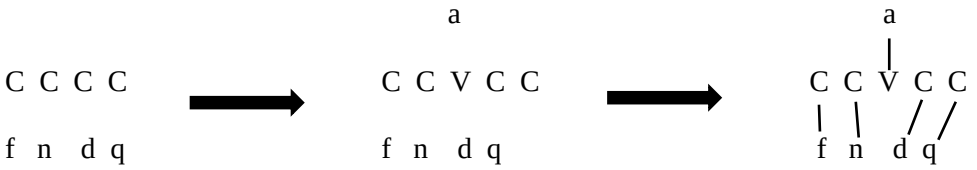


As for the broken plural pattern CCVCəC, the broken plural formation of the nouns *fəndəq* (‘hotel’) and *xatəm* (‘ring’) derived from the quadrisegmental roots CCCC and CVCC respectively

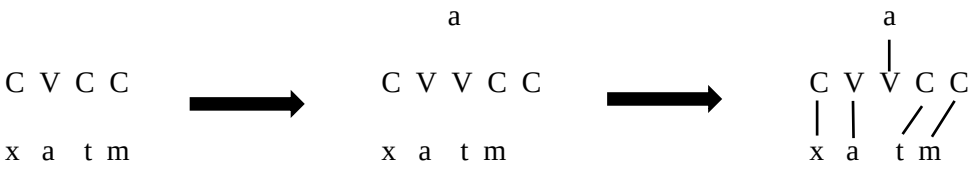
is shown in (45). The syllabification of the outputs of (45a) and (45b) is illustrated in (46a) and (46b), respectively.

(45) Insertion of the Broken Plural Morpheme *-a*

a.

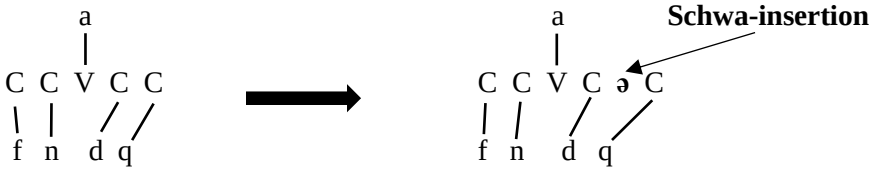


b.

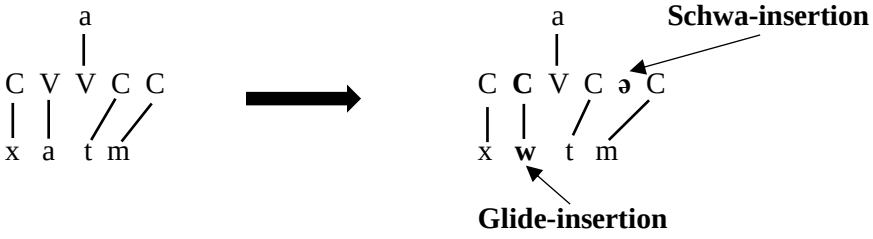


(46) Syllabification: Schwa/Glide-insertion

a.



b.



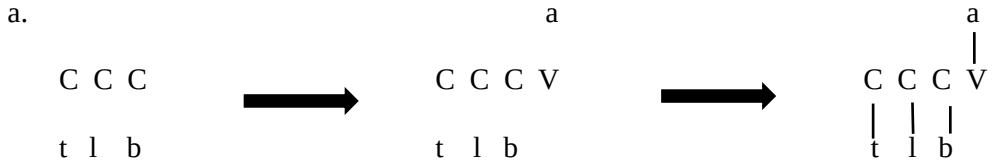
To conclude, Al Ghadi (1990) puts forward an interesting proposal with respect to broken plural formation in MA. The analysis proposed showed how broken plurals in MA can be accounted for more sufficiently through a series of steps including affixation and syllabification. Moreover, by suggesting that broken plurals are derived from nominal roots, Al Ghadi avoids all the complications that faced the analyses in which singulars are taken as inputs to broken pluralization.

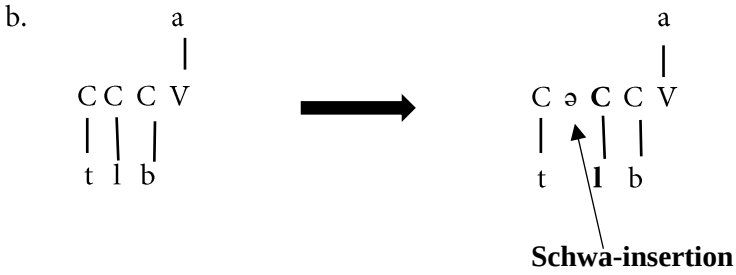
3.5.3. The Drawbacks of Al Ghadi (1990) Account of Moroccan Arabic Broken Plurals

Despite the interesting proposals in Al Ghadi's (1990) account of broken plurals in MA, his proposal has some drawbacks. By attempting to account for almost all broken plural patterns in MA, Al Ghadi had to propose three different broken plural morpheme shapes (V, CV, and VC) that are inserted in different positions depending on the nature of the root. The broken plural morpheme V, for instance, is infixed in words like *ʃkəl* and *fəndəq* as shown in (43a) and (45a) above, and it is suffixed in words like *talb* ('religious school teacher') as seen in (47). Second, in Al Ghadi's account, a root shape can have various broken plural patterns, and a broken plural pattern can be derived from multiple roots. It can be seen from (43) and (47), for instance, that the broken plurals *ʃkal* and *təlba* are both derived from the CCC roots *ʃkl* and *tlb*, but have different broken plural forms. Similarly, the broken plurals *bTayən* ('sheepskins') and *gyaTən* ('tents') have the same broken plural patterns CCVCəC, but are derived from different root shapes *bTn* and *giTn*. As a result of these issues, a broken plural cannot be predicted based on a given root, and vice versa. In other words, Al Ghadi's account of broken plural formation in MA does not account for which broken plural is derived from which root.

(47)

a.





(Al Ghadi, 1990, pp. 145)

3.6. Conclusion

A number of theoretical frameworks have been used in an attempt to understand the behavior of broken plurals in CA. First, we have seen how the Root-and-patterns approach had been traditionally used to explain morphological processes in Semitic languages until the late 70s. This approach was unable to account for the relation between different broken plural patterns and, thus, results in a highly allomorphic broken plural system. The second attempt to deal with broken plural formation was proposed by McCarthy (1983) using his theory of Non-concatenative Morphology. Although his analysis was able to come up with a system that can overcome the drawbacks of the traditional Root-and-patterns approach through the use of autosegmental principles, it was able to account only for the major productive broken plural patterns, not all of them. The third account of CA broken plurals discussed in this chapter was proposed by McCarthy & Prince (1990) using Prosodic Morphology. This account works by mapping the singular noun onto the broken plural template through the use of Prosodic Circumscription analysis. The latter functions by taking the content of the initial heavy syllable (two moras) of the singular and mapping it onto the broken plural template CVCVV. McCarthy (1997), however, argues that this analysis has some drawbacks, especially the fact that it does not work for singulars that do not begin with a heavy syllable. McCarthy (1997) argues that Output-output Correspondence Theory in OT works better as an account of broken plurals in CA. He proposed that broken plural formation in CA can

be analyzed mainly through the use of prosodic faithfulness constraints in OT. Applying this analysis to broken plurals in MA, however, cannot work the same way it does in CA simply because the observations based on which this analysis was proposed are not always seen in MA broken plural data. That is, there are some major broken plural patterns in MA where some tokens exhibit the preservation of the weight of the final syllable of singulars and the existence of the added mora seen in CA and some other tokens do not.

Al Ghadi (1990) is the only unified account of MA broken plurals. His analysis is based on the assumption that broken plurals are formed cyclically in two stages; in the first one, affixation of the broken plural morpheme takes place, while syllabification occurs at the second stage. Unlike McCarthy and Prince who argue that broken plurals in CA are derived from their corresponding singulars, broken plurals in MA, according to Al Ghadi, are derived from the root. Although Al Ghadi (1990) uses an outdated theoretical framework (i.e. Autosegmental Phonology) to account for this phenomenon, the Stratal OT account that will be used in the present thesis shares the main assumption made by Al Ghadi.

Chapter 4: Stratal Optimality Theory As an Account of Broken Plural Formation in Moroccan Arabic

4.1. Introduction

This chapter presents the theoretical framework adopted in the present thesis, i.e. the Stratal model of Optimality Theory. The second section of this chapter introduces the assumptions and hypotheses that Stratal OT is based on. An example from Arabic is used to show why a cyclic approach to phonology avoids problems encountered by parallel approaches in cases involving phonological opacity. The third section shows how Cyclicity can be a solution to the problematic broken plural formation in MA and explains how this approach works for the major MA broken plural patterns.

4.2. Stratal Optimality Theory

Stratal Phonology is a theory that was developed to explain the interactions of phonology with other components of grammar. The theory proposes that phonology applies in a cyclic manner over domains of the morphosyntactic structure. In other words, Stratal Phonology came to account for some phenomena in which a series of phonological processes occur cyclically to a specific input. The theory draws its main assumptions from the theory of Lexical Phonology (Kiparsky, 1982; Mohanan, 1982; among others). However, unlike the latter, which emphasizes the

importance of Strict Cyclicity and Structure Preservation as mechanisms used to constrain the application of rules at the stem level, Stratal Phonology rejects these hypotheses. In addition to distinct lexical levels, Lexical Phonology also requires rule ordering within levels. In Stratal OT, on the other hand, ordering is restricted to a limited number of morphologically motivated parallel OT evaluations. Typically, these are the stem, word, and phrase level.

There are two main fundamental principles that Stratal Phonology is based on: **Cyclicity** and **Stratification.** The former proposes that phonology contains different cycles through which linguistic expressions are derived. One strong argument for Cyclicity in Stratal Phonology stems from cases of phonological opacity, which was defined by Kiparsky (1973) as follows:

(48) Opacity

A phonological rule P of the form A → B / C_D is opaque if there are surface structures with either of the following characteristics:

a. instances of A in the environment C_D.
b. instances of B derived by P that occur in environments other than C_D.

Kiparsky (1973)

One well-known example of these cases comes from the underapplication of syncope in Palestinian Arabic (Brame, 1970; Kiparsky, 1973). In this language, stress, which falls on the penultimate syllable, interacts with vowel deletion; the rule states that unstressed /i/ is deleted in open non-final syllables as shown in (49).

(49)

/fihim/	'to understood'
[fíhim]	'he understood'
[fhím-na]	'we understood'
[fíhm-u]	'they understood'

Consider the additional data in in (50).

(50)

/fihim/	‘to understood’
[fíhim]	‘he understood’
[fihím-na]	‘he understood us’

If the rules introduced above apply normally, the word for ‘he understood us’ would have the form **fhímna*. This, however, is not the case, and i-deletion seems to be blocked. Kiparsky (2000) argues that the underapplication of i-deletion can be analyzed using a cyclic approach to phonology. According to Kiparsky, i-deletion applies to the word for ‘we understood’ and not to the one for ‘he understood us’ because subject suffixes and object and possessive suffixes belong to different layers (cycles) of morphology. (51) shows the cyclic derivation of the words for ‘we understood’ and ‘he understood us’.

(51)

input	[fihim-na]Subj	[[fihim-Ø]Subj na]Obj
Cycle 1		
Stress	fihím-na	fíhim-Ø
Cycle 2		
Stress		fìhím-Ø-na
Postcyclic		
i-Syncope	fhím-na	Blocked
Destressing		fihím-Ø-na
Output	fhímna	fihímna
	‘we understood’	‘he understood us’

As can be seen in (51), the suffixation of subject pronouns occurs at the first cycle, while the suffixation of object pronouns occurs at the second cycle. In this case, both vowels in the form ‘he understood us’ are stressed at the postcyclic level, which blocks i-deletion.

In addition to the principle of Cyclicity, Stratal Phonology is based on the Theory of Stratification. Unlike the preceding cyclic frameworks, the Theory of Stratification in Stratal Phonology proposes that the number of cyclic domains is limited. Also, this theory makes use of the following categories:

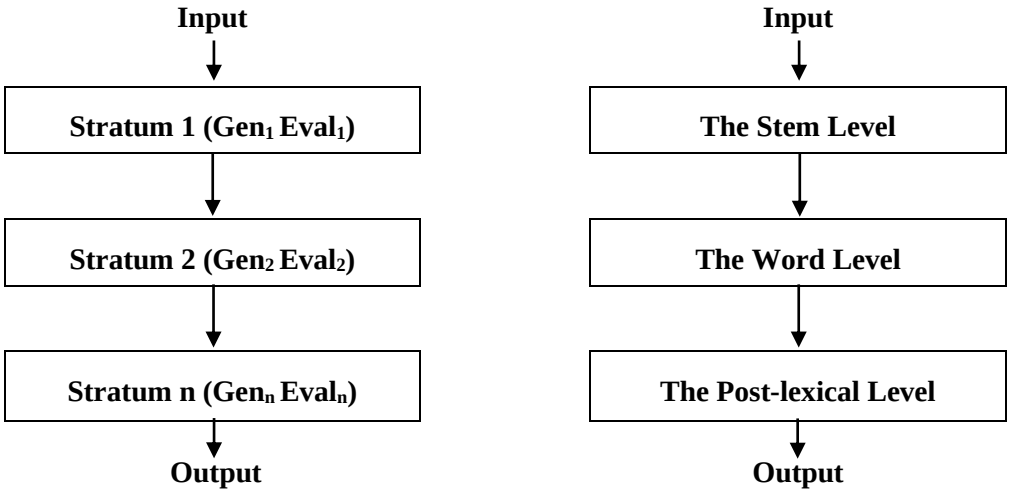
a. A **root** (√) is a minimal acategorial lexical item.
b. A **stem** is a lexical item specified for syntactic category (N, V, A, etc).
c. A **word** is a syntactically autonomous lexical item bearing the full set of inflectional features required by its category.

(Bermúdez-Otero, 2017)

Bermúdez-Otero (2006) puts forward two main generalizations regarding these categories. First, roots do not define cyclic domains. Second, stems, words, and utterances can all define cyclic domains for the stem-level, word-level, and phrase-level phonology respectively.

A constraint-based implementation of Stratal Phonology is Stratal OT (Kiparsky, 2000; Bermúdez-Otero, 2003). In this approach, the phonology contains an ordered series of OT evaluations that take place at multiple strata (cyclic domains). Inputs, in this framework, are free at the initial level, and the constraint ranking determines the inventory of segments and the constraints regulating morpheme structure. In Stratal OT, the output of the initial stratum serves as the input to the second stratum, and the output of the latter, in turn, serves as the input to the following stratum and so on. As far as Arabic is concerned, three levels are argued for by Kiparsky (2000, 2003): the stem level, the word level, and the post-lexical level. The input of each level serves as the output of the next one. This process is illustrated in (52).

(52)



Unlike the traditional OT approach in which outputs are evaluated in a parallel manner, Stratal OT adopts a cyclic approach to phonology. This approach proves to be better in analyzing cases of morpho-phonological opacity that a classic parallel OT approach would fail to handle.

4.3. Cyclicity in Moroccan Arabic Broken Plural Formation

This thesis assumes that broken plurals are formed from the underlying nominal roots and proposes that there are two levels involved in broken plural formation: the stem level and the word level; the broken plural morpheme infixation occurs at the stem level, while syllabification occurs at the word level. The root in CA has been conceived of as an underlying sequence of consonants, hence the term consonantal root. In other Afroasiatic languages like MA and Berber, the root can also contain vowels (Al Ghadi, 1990; Bensoukas, 2001; and Noamane, 2018). The conception of the root proposed in this thesis can be summarized as follows:

- Roots can either be trisegmental or quadrasegmental. They cannot exceed four segments.
- Roots mainly consist of consonants including geminates.
- Roots can contain vowels. A root usually contains no more than one vowel.

Like Al Ghadi (1990), this thesis assumes roots to be trisegmental or quadrasegmental and to consist of both consonants and vowels. However, roots, according to Al Ghadi, do not consist of geminates. The vowels in the root play an important role since their existence both reveals which broken plural patterns some nouns take and determines which glide (/w/ or /j/) is epenthesized when forming the broken plural of those nouns.

MA broken plurals, then, are formed cyclically through two levels. The input of the stem level is the root; at this level, the infixation of the plural vowel takes place. The output of the stem level is the input to the word level at which constraints requiring syllabic well-formedness are high ranked. The output of this level is the surface broken plural form. (Table 8) shows an example of the broken plural formation of the MA noun *fəndəq* (‘hotel’) using this system.

Table 8: The broken plural Formation of the Word fəndəq

The Stem Level	**Input**	/fndq/ + /a/
	Plural Infixation	fnadq
	Output	[fnadq]
The Word Level	**Input**	/fnadq/
	Epenthesis	fnadəq
	Output	[fnadəq]

The approach proposed above will not only work for broken plurals of the form CCVC and CCVCəC, but will also be able to handle the productive broken plural pattern CCVC-i shown in (53a). Based on what we have seen before, one would argue that these nouns should have the broken plural pattern CCVC (53b) since they all have trisegmental roots. However, as mentioned in Chapter 2, these nouns present a special case because they are feminine nouns; they are marked by the existence of a feminine suffix, in this case -*i*[9]. The suffixation of feminine -*i* takes place at the word level along with epenthesis and other processes that ensure well-formed syllable structure. (54) shows the cyclic derivation of the words *klab* (‘dogs’) and *rkabi* (‘knees’) that are derived from the root CCC.

(53)

	Root	**Singular**	**Plural**	**Gloss**
a.	ʒrd	ʒərda	ʒradi	‘garden’
	rkb	rəkba	rkabi	‘knee’
	kur	kura	kwari	‘ball’
b	klb	kəlb	klab	‘dog’
	bʕd	bʕid	bʕad	‘far, distant’
	bir	bir	bjar	‘well’

[9] Singular nouns that are marked for the feminine gender has the suffix -*a*.

(54)

Input	/klb/ + /a/	/rkb/ + /a/
Stem level		
Plural Infixation	klab	rkab
Word level		
FmGr-suffixation	____	rkabi
Syllabification	klab	rkabi
Output	[klab]	[rkabi]
	'dogs'	'knees'

(Table 9) shows the major the major broken plural patterns that will be analyzed in the next chapter along with the roots they are derived from. (Table 9) also presents the different shapes of these forms in the different stages of the derivation.

Table 9: The Derivation of the Major broken plural patterns of MA

Roots (Stem Level Inputs)	**Stem Level Output/ Word Level Inputs**	**BROKEN PLURAL Patterns (Word Level Outputs)**
CCCC	CCVCC	CCVCəC
CVCC	CVVCC	
CCC	CCVC	CCVC / CCVCi
CVC	CVVC	

4.4. Conclusion

This chapter was a brief presentation of the Stratal model of OT as an account of broken plural formation in MA. It has been shown that the latter is a phenomenon that occurs cyclically in two stages. At the first stage (the stem level), a process of broken plural infixation takes place. At the second (the word level), epenthesis and syllabification take place, the result of which is the broken plural surface form. As for cases involving feminine trisegmental roots, a process of suffixation goes along with syllabification at the word level. The Stratal OT analysis that will be presented in the next chapter will account for the major broken plural patterns in MA shown in Chapter 2: CCVCəC, CCVC, and CCVCi.

Chapter 5: A Stratal Optimality Theory Analysis of Moroccan Arabic Broken Plurals

5.1. Introduction

We have seen in the last chapter that Cyclicity is an approach that can account for the internal changes that take place in MA roots when forming their broken plural counterparts. Broken plural formation, as has been shown, is a process that takes place over two levels: the stem level and word level. The infixation of the broken plural vowel occurs at the former, and epenthesis and syllabification occur at the latter. We have also seen that gender suffixation also occurs at the word level in case the broken plural is derived from a trisegmental feminine root. In this chapter, a Stratal OT analysis will be presented in the light of these generalizations. The constraints that will be used in this analysis are constraints that relate to the phonology, prosody, and morphology of MA.

The analysis will be presented in two parts. The first is devoted to the stem level analysis. This section shows how broken plural infixation takes place at the stem level by providing a set of constraints along with a proposed ranking for the major broken plural patterns. Inputs of this level are both trisegmental and quadrisegmental roots CXC and CXCC. The second part of the analysis will present a word level analysis of the major broken plurals in MA. The constraints and ranking provided will account for syllabification and epenthesis that take place at this level. The input forms to this level are the output forms of the stem level as mentioned before. The fourth section in this chapter will present full mappings of the derivation of some examples of broken plural forms in MA at both levels.

5.2. Stem-level Analysis

5.2.1. Introduction

As shown in the previous chapter, the most important step in Broken Pluralization in MA, i.e. the infixation of the broken plural vowel, occurs at the stem level. This section provides an OT analysis of this process. The stem level constraint ranking that will be provided will show why the broken plural vowel is infixed and not suffixed, as in MA sound plurals. This analysis will also be the basis for the word level analysis that will be presented[10]. This section is divided into two main subsections. The first one will deal with the broken plural forms derived from entirely consonantal roots (CCCC and CCC). The second one will analyze the forms whose roots contain vowels (CVCC and CVC).

5.2.2. The Roots CCC and CCCC

We have seen before that CXC and CXCC nominal roots in MA are inputs to the highly productive broken plural patterns CCVC(i) and CCVCəC, respectively. This section will be devoted to the stem level OT analysis of the broken plural patterns derived from CCC and CCCC roots. It has been shown in the last chapter that, at the stem level, the broken plural vowel is infixed, which results in the stem level output forms CCVC (55a) and CCVCC (55b).

[10] It should be noted that the outputs of all tableaux in this section are not the surface broken plural forms but they are abstract forms that are themselves inputs to the word level, which will be dealt with in section 5.3. The outputs of the word level are the surface broken plural forms.

(55)

	Root	Stem Level Output	Broken Plural Surface Form	Gloss
a.	klb	klab	klab	‘dog’
	ħbb	ħbab	ħbab	‘lovers’
b.	fndq	fnadq	fnadəq	‘hotel’
	sllm	slalm	slaləm	‘ladder’

Infixation in MA broken plurals can be seen as a result of the interaction between the constraint ALIGN-PL-RIGHT and other markedness and faithfulness constraints. ALIGN-PL-RIGHT comes from the ALIGN family of constraints that were proposed by McCarthy & Prince (1993) and that require alignment between the edge of a grammatical category and the corresponding edge of a prosodic constituent. The main constraints that interacts with ALIGN-PL-RIGHT is *CCC. This constraint is well-known crosslinguistically and is based on MA data as well since MA does not allow a sequence of three consonants. These two constraints can be defined as follows:

- **ALIGN-PL-RIGHT**: the plural vowel must be aligned with the right edge of the word.
- ***CCC**: do not have three adjacent consonants.

The tableaux in (56) and (57) show ranking arguments for these two constraints at the stem level with respect to the infixation of the broken plural vowel for the CCC and CCCC roots.

(56) Stem-level evaluation of /klb/ + /a/

/klb/ + /a/	*CCC	ALIGN-PL-RIGHT
☞ **klab**		*
klba	*!	

(57) Stem-level evaluation of /fndq/ + /a/

/fndq/ + /a/	*CCC	ALIGN-PL-RIGHT
☞ **fnadq**		**
fndqa	*!	
fndaq	*!	*

As can be seen in (56) and (57), ranking ALIGN-PL-RIGHT below *CCC guarantees that the optimal candidates *klab* and *fnadq* win. The other candidates, which have the broken plural vowel as a suffix, violate *CCC, which is ranked higher than ALIGN-PL-RIGHT, and, thus, are ruled out.

The issue of three adjacent consonants can also be fixed through the insertion or deletion of a segment. In this case, the broken plural vowel can be suffixed. However, insertion and deletion are not preferred in MA at the stem level. The relevant constraints that are used are DEP-IO and MAX-IO:

- **DEP-IO**: each segment in the output has a corresponding segment in the input.
- **MAX-IO**: each segment in the input has a corresponding segment in the output.

DEP-IO and MAX-IO are ranked higher than ALIGN-PL-RIGHT as can be seen in (58) and (59). This ranking argument guarantees that the optimal candidates that involve infixation win.

(58) Stem-level evaluation of /klb/ + /a/

/klb/ + /a/	MAX-IO	DEP-IO	ALIGN-PL-RIGHT
☞ klab			*
kalba		*!	
kla	*!		

(59) Stem-level evaluation of /fndq/ + /a/

/fndq/ + /a/	MAX-IO	DEP-IO	ALIGN-PL-RIGHT
☞ fnadq			**
fnadqa		*!	
fna	*!		

As shown in (58) and (59), the optimal candidates *fnadq* and *klab* satisfy the highly ranked constraints MAX-IO and DEP-IO, while the other two candidates in both tableaux violate either of these constraints, and, therefore, lose.

We can conclude from the tableaux shown so far that the ranking of constraints for the broken plurals that are derived from the roots CCCC and CCC shown in (55) at the stem level is

as follows: **MAX-IO; DEP-IO; *CCC >> ALIGN-PL-RIGHT**. (60) shows the tableau containing all the constraints and the possible candidates derived from the root CCCC.

(60) Stem-level evaluation of /fndq/ + /a/

/fndq/ + /a/	MAX-IO	DEP-IO	*CCC	ALIGN-PL-RIGHT
☞ fnadq				**
fndqa			*!	
fndaq			*!	*
fnadqa		*!		
fna	*!			

The optimal candidate *fnadq*, although it violates ALIGN-PL-RIGHT twice, satisfies all the highly ranked constraints. The second and third candidates (*fndqa* and *fndaq*) violate *CCC by having a sequence of three adjacent consonants. The fourth candidate *fnadqa* violates DEP-IO by having an epenthesized segment (the vowel [*a*]). In the last candidate *fna*, two input segments are absent ([d] and [q]), which is a violation of MAX-IO twice. It should be noted that MAX-IO, DEP-IO, and *CCC are not ranked with respect to each other since that does not affect the winning candidate.

The same ranking was also shown to work for broken plurals derived from the root CCC. (61) shows tableau that has a triconsonantal root as the input.

(61) Stem-level evaluation of /klb/ + /a/

/klb/ + /a/	MAX-IO	DEP-IO	*CCC	ALIGN-PL-RIGHT
☞ klab				*
kalb				**!
klba			*!	
klaba	*!			
kla		*!		

As in the forms derived from CCCC roots, the optimal candidate *klab* in (61) satisfies all constraints and has a single violation of ALIGN-PL-RIGHT as a result of infixation. The second candidate *kalb* loses since it violates ALIGN-PL-RIGHT twice as it has the broken plural vowel two segments away from the right edge of the word. The third candidate *klba* has three adjacent candidates, so it violates

*CCC. The fourth and fifth candidates (*klaba* and *kla*) violate MAX-IO and DEP-IO respectively and, thus, also ruled out.

5.2.3. The Roots CVC and CVCC

In addition to the entirely consonantal roots presented in the last section, the broken plural patterns CCVC and CCVCəC can also be derived from the roots CVC and CVCC (62). The stem level constraint ranking shown above, however, is not sufficient to account for the forms in (62a) as can be seen in (63).

(62)

	Root	Stem Level Output	Broken Plural Surface Form	Gloss
a.	bir	biar	bjar	'well'
	bit	biut	bjut	'room'
b.	xatm	xaatm	xwatəm	'ring'
	BlaS	BlaaS	BlajəS	'place'

(63) Stem-level evaluation of /bir/ + /a/

/bir/ + /a/	MAX-IO	DEP-IO	*CCC	ALIGN-PL-RIGHT
☹ **biar**				*!
bair				*!*
☞ **bira**				
baiar	*!			
bra		*!		

In (63), the third candidate *bira* wins since it does not have a single violation of any of the proposed constraints, while the first candidate *biar*, which is the actual stem level output, loses by violating ALIGN-PL-RIGHT once. It can be seen from (63) that the constraint *CCC is irrelevant since no candidate has a sequence of three adjacent consonants due to the existence of a vowel in the root. The same result occurs with respect to the forms in (62b). It can be seen in (64) that the actual stem level output does not win if we use the same constraints used in (60).

(64) Stem-level evaluation of /xatm/ + /a/

/xatm/ + /a/	MAX-IO	DEP-IO	*CCC	ALIGN-PL-RIGHT
☹ **xaatm**				****!**
xaatm				*****!**
☞ **xatma**				
xatam				***!**
xataam		***!**		*****
xtam	***!**			*****

As in (63), the candidate *xatma*, in (64), wins over the actual stem level output *xaatm* since having a vowel in the root prevents it from violating *CCC. This issue can be fixed by proposing additional constraints that can be used to rule out candidates like *bira* in (63) and *xatma* in (64).

Let us first focus on the forms in (62a). A constraint that can be proposed to ensure that the actual stem level output CV**V**C, which is *biar* in (63), wins is ANCHOR L/R; this is one of the ANCHOR constraints that were proposed by McCarthy & Prince (1995, 1999). As defined below, this constraint ensures that the broken plural vowel is not suffixed, but rather infixed. By ranking this constraint higher than ALIGN-PL-RIGHT, the actual ST output *biar* wins over *bira* in which the broken plural vowel is suffixed as can be seen in (65).

- **ANCHOR L/R**: any segment at the designated edge of the stem has a correspondent at the same edge of the output.

(65) Stem-level evaluation of /bir/ + /a/

/bir/ + /a/	ANCHOR L/R	ALIGN-PL-RIGHT
☞ **biar**		*
bira	***!**	

(65) shows that ANCHOR L/R is the perfect solution to the problem encountered when analyzing the broken plurals that are derived from the root CVC at the stem level. This constraint ensures that the broken plural vowel is infixed and, thus, rules out any candidate in which it is suffixed.

The constraint ranking that we have so far is the following[11]: **MAX-IO; DEP-IO; ANCHOR L/R >> ALIGN-PL-RIGHT**. (66) shows the tableau containing all these constraints and the possible candidates derived from the root CVC.

(66) Stem-level evaluation of /bir/ + /a/

/bir/ + /a/	DEP-IO	MAX-IO	ANCHOR L/R	ALIGN-PL-RIGHT
☞ **biar**				*
bair				**!
bira			*!	
bar		*!		*
baiar	*!			*

In (66), the optimal candidate *biar* wins by satisfying the constraints MAX-IO, DEP-IO, and ANCHOR L/R although it violates ALIGN-PL-RIGHT once. The second candidate violates ALIGN-PL-RIGHT twice and, thus, loses. The fourth and fifth candidates violate MAX-IO and DEP-IO, respectively, which are ranked high. The third candidate *bira* is ruled out by violating ANCHOR L/R as has already been seen in (65).

Now, we turn to the forms in (62b) that are derived from the root CVCC. The ranking proposed in (66) will rule out the candidate that has the broken plural vowel as a suffix by violating ANCHOR L/R. However, as can be seen in (67), the winning candidate will still not be the actual output CV**V**CC, but the candidate with the form CVC**V**C.

(67) Stem-level evaluation of /xatm/ + /a/

/xatm/ + /a/	MAX-IO	DEP-IO	ANCHOR L/R	ALIGN-PL-RIGHT
☹ **xaatm**				**!
xaatm				***!
xatma			*!	
☞ **xatam**				*
xataam		*!		*
xatm	*!			**

[11] The constraint *CCC is not mentioned here since it is irrelevant to the analysis at this point.

In (67), the candidate *xatam* wins over the actual candidate *xaatm*. Although both of them satisfy the highly ranked constraints MAX-IO, DEP-IO, and ANCHOR L/R, *xatam* wins since it violates ALIGN-PL-RIGHT only once, whereas *xaatm* does so twice.

To fix this issue, an additional constraint needs to be proposed. A constraint that can be used at this point is CONTIGUITY-CC, which comes from the CONTIGUITY constraints proposed by McCarthy & Prince (1995).

- **CONTIGUITY-CC**: any sequence of two adjacent consonants in the input must be adjacent in the output.

This constraint will ensure that infixation between adjacent consonants in the input is not preferred. Ranking this constraint higher than Alight-PL-Right will guarantees that the candidate with the form CV**V**CC wins over CVC**V**C which infixes the vowel between a sequence of two consonants (CC). (68) shows this ranking argument.

(68) Stem-level evaluation of /xatm/ + /a/

/xatm/ + /a/	CONTIGUITY-CC	ALIGN-PL-RIGHT
☞ **xaatm**		****!**
xatam	***!**	*****

(68) shows that the actual stem level output *xaatm* wins by satisfying the highly ranked CONTIGUITY-CC constraint. On the other hand, *xatam* violates the latter by infixing the broken plural vowel between the adjacent consonants /t/ and /m/.

The constraint ranking that we have so far is the following: **MAX-IO; DEP-IO; ANCHOR L/R; CONTIGUITY-CC >> ALIGN-PL-RIGHT**. (69) shows the tableau containing all these constraints and the possible candidates derived from the root CVCC.

(69) Stem-level evaluation of /xatm/ + /a/

/xatm/ + /a/	MAX-IO	DEP-IO	ANCHOR L/R	CONTIGUITY-CC	ALIGN-PL-RIGHT
☞ xaatm					**
xaatm					***!
xatma			*!		
xatam				*!	
xataam		*!		*	*
xatm	*!				**

In (69), the optimal candidate *xaatam* wins by satisfying all the constraints except for the lowest constraint ALIGN-PL-RIGHT, which is violated twice. The second candidate *xaatam*, which infixes the broken plural vowel three segments away from the right edge of the word, loses by violating ALIGN-PL-RIGHT three times. The third candidate *xatma* violates the highly ranked constraint ANCHOR L/R by attaching the broken plural vowel as a suffix. The fourth candidate *xatam* loses by violating CONTIGUITY-CC as shown in (68). The last two candidate (*xataam* and *xatm*) violate DEP-IO and MAX-IO respectively and are, therefore, ruled out as well.

It should be pointed out that CONTIGUITY-CC is ranked lower than *CCC as this will guarantee that the actual stem level output for the forms in (55) is the optimal candidate. If *CCC was ranked lower than CONTIGUITY-CC, the candidates that have the broken plural vowel as a suffix would win. (70) and (71) shows that this ranking argument is crucial as far as those forms are concerned.

(70) Stem-level evaluation of /fndq/ + /a/

/fndq/ + /a/	*CCC	CONTIGUITY-CC
☞ fnadq		*
fndqa	*!	

(71) Stem-level evaluation of /klb/ + /a/

/klb/ + /a/	*CCC	CONTIGUITY-CC
☞ klab		*
klba	*!	

5.2.4. Conclusion

This section presented the stem level OT analysis of the broken plural formation of the major broken plural patterns in MA. The first part of this section dealt with the broken plurals derived from the roots CCCC and CCC, and the second part was devoted to the ones derived form the roots CVCC and CVC. The combined constraint ranking at the stem level is the following: ***CCC >> MAX-IO; DEP-IO; ANCHOR L/R; CONTIGUITY-CC >> ALIGN-PL-RIGHT**. This ranking is able to generate the actual stem level outputs that are shown in (72) and that will serve as inputs to the word level analysis that will be presented in the following section.

(72)

Stem Level inputs (Roots)	Stem Level Outputs / Word Level Inputs
CCC	CC**V**C
CCCC	CC**V**CC
CVC	CV**V**C
CVCC	CV**V**CC

5.3. Word-level Analysis

5.3.1. Introduction

In the first part of this analysis, we have seen how broken plural infixation that takes place at the stem level is analyzed using a set of constraints together with a proposed ranking. It was shown that the inputs to this stem level OT analysis are both trisegmental and quadrisegmental roots of the forms CCC, CCCC, CVC, and CVCC. The stem level outputs for the roots CCC and CCCC are CCVC and CCVCC, respectively, while the stem level outputs for the roots CVC and CVCC are CVVC and CVVCC, respectively, as shown in (72). In this section, I propose a word

level OT analysis that shows how the broken plural surface forms CCVC, CCVCi and CCVCəC are derived from those forms. The first subsection will deal with the broken plural forms derived from the entirely consonantal roots (CCC and CCCC), while the second one will be devoted to the roots that have vowels in them (CVC and CVCC).

5.3.2. The Roots CCC and CCCC

Let us, first, begin with the forms in (55a). It can be seen that the word level input (i.e. stem level output) of these triconsonantal roots is actually similar in shape to the word level output (i.e. surface broken plural form) as shown in (73); in other words, no change takes place in these forms at the word level. This is, in fact, due to the interaction of constraints at this level as will be shown below.

(73)

Root	**Stem Level Output**	**Word Level Output**	**Gloss**
klb	klab	klab	'dog'
ħbb	ħbab	ħbab	'lovers'
frx	frax	frax	'chicks'

In order to understand the derivation of the forms in (73), a discussion about the constraints of syllable structure and prosody in MA that was briefly discussed in Chapter 2 is needed. First of all, a reminder of the main assumptions about MA syllabification should be mentioned; these assumptions include the following:

- Possible syllable shapes in MA include three light syllables and one heavy syllable: CV, CəC, and C are light syllables. CVC is the only heavy syllable in MA.
- The syllable C is called a minor syllable (also degenerate syllable), while the other syllables, CV, CəC, and CVC, are called major syllables.

- The epenthetic vowel in MA is the schwa.

It has been seen in chapter 2 that syllables that consist of a single consonant and no vowels (i.e. minor syllables) are motivated in MA due to the fact that a lexical word is equivalent to a prosodic word and that the latter should at least contain one binary foot. So, in order for words of the form CCV, like *bka*, *bqa*, and *nsa*, to be prosodic words, for instance, we need to analyze them as words that contain two syllable (i.e. one foot) C and CV. That is to say, having a minor syllable in MA is preferred to having a complex onset since having the latter in words of the form CCV would mean a violation of the constraints that require a lexical word to be a prosodic word and feet to be binary. This fact can be accounted for in OT through the interaction of the constraints *COMPLEX-MARGIN (Prince and Smolensky, 1993) and *MIN-σ (Boudlal, 2001).

- ***COMPLEX-MARGIN**: codas and onsets must not branch.
- ***MIN-σ**: minor syllables are prohibited.

The constraint *COMPLEX-MARGIN (henceforth *COMPLEX-M), which prohibits both onsets and codas from having more than one consonant, is ranked higher than *MIN-σ, which is violated by the existence of a minor syllable, as the tableau in (74) shows.

(74) Word-level evaluation of /klab/

/klab/	*COMPLEX-M	*MIN-σ
☞ k.lab		*
klab	* !	

In (74), although the first candidate violates *MIN-σ by having a minor syllable, it wins since it satisfies the highly ranked constraint *COMPLEX-M, while the second candidate violates the latter by having a complex onset and, thus, loses.

Having a minor syllable in MA is also preferred over insertion or deletion. This can be seen form the interaction of *Min-σ with Dep-io and with Max-io in (75).

(75) Word-level evaluation of /klab/

/klab/	Max-io	Dep-io	*Min-σ
☞ k.lab			*
kab	*!		
kə.lab		*!	

Ranking *Min-σ below both Max-io and Dep-io guarantees that the actual broken plural form wins as seen in (75). The latter, i.e. *k.lab*, satisfies both Max-io and Dep-io while violating *Min-σ once. The second candidate *kab* violates Max-io by deleting an input segment, and the third candidate *kə.lab* violates Dep-io by inserting a schwa to prevent the existence of a minor syllable. Both *kab* and *kə.lab* are ruled out since Max-io and Dep-io are higher in ranking than *Min-σ.

So far, we can say that the word level constraint ranking that is used to derive the surface broken plurals of the forms in (73) is the following: ***Complex-m[12]; Max-io[13]; Dep-io >> *Min-σ**. (76) shows the tableau containing all these constraints and the possible candidates derived from the word level input CCVC.

(76) Word-level evaluation of /klab/

/klab/	*Complex-m	Max-io	Dep-io	*Min-σ
☞ k.lab				*
k.la.b				**!
klab	*!			
kab		*!		
kə.lab			*!	

As shown in (76), the first candidate *k.lab* wins by satisfying all the highly ranked constraints and violating *Min-σ once. The second candidate *k.la.b* loses by violating the latter twice. The third

[12] It should be pointed out that *Complex-m is reranked at the word level. Although it's not mentioned at the stem level analysis, it must be ranked below the faithfulness constraints Max-io and Dep-io at the stem level.
[13] Max-io cannot be violated at both the stem level and the word level, and, thus, is ranked high at both levels.

candidate *klab* violates *Complex-m and is, thus, ruled out. The fourth and fifth candidates, *kab* and *kə.lab*, violate Max-io and Dep-io, respectively, and, therefore, lose.

In addition to the forms in (73), there are other similar forms that are derived from the same word level input, CCVC, and have different broken plural surface form, CCVCi (77). As mentioned in chapter 2, the vowel [i] that is attached at the end of these forms is a feminine marker associated with feminine nouns of trisegmental roots. This suffixation takes place along with syllabification at the word level as was mentioned in chapter 4. The ranking proposed in (76) above, however, cannot alone work for these forms as seen in (78) below.

(77)

Root	**Word Level input**	**Broken Plural form**	**Gloss**
ʒrd	ʒrad	ʒradi	'garden'
rkb	rkab	rkabi	'knee'

(78) Word-level evaluation of /rkab/ + /i/

/rkab/ + /i/	***Complex-m**	**Max-io**	**Dep-io**	***Min-σ**
☹ **r.ka.bi**				*
☞ **ri.kab**				

In (78), both candidates satisfy *Complex-m, Max-io, and Dep-io. The second candidate *ri.kab*, however, wins by infixing the vowel [i] and, thus, satisfying *Min-σ as well, which is violated by the actual broken plural form *r.ka.bi*. that has the vowel as a suffix.

This issue can be fixed by proposing the constraint Align-fm-right, which requires that the feminine marker be aligned with the right edge of the word.

- **Align-fm-right**: the feminine vowel must be aligned with the right edge of the word.

Ranking this constraint higher than *Min-σ will rule out any candidates that infixes the feminine vowel like the second candidate in (78). This ranking argument can be shown in (79).

(79) Word-level evaluation of /rkab/ + /i/

/rkab/ + /i/	ALIGN-FM-RIGHT	*MIN-σ
☞ r.ka.bi		*
ri.kab	***!	

ALIGN-FM-RIGHT must also outrank ANCHOR L/R[14] since the latter rules out any cases in which the -i is suffixed. Adding ALIGN-FM-RIGHT to the constraints shown before, the constraint-ranking we have is the following: **ALIGN-FM-RIGHT >> *COMPLEX-M; MAX-IO; DEP-IO; ANCHOR L/R >> *MIN-σ**. (80) shows the tableau containing all these constraints and the possible candidates derived from the word level input CCVC and through which the broken plural forms in (77) are formed.

(80) Word-level evaluation of /rkab/ + /i/

/rkab/ + /i/	ALIGN-FM-RIGHT	*COMPLEX-M	MAX-IO	DEP-IO	ANCHOR L/R	*MIN-σ
☞ r.ka.bi					*	*
ri.kab	*!					
rka.bi		*!			*	
ka.bi			*!		*	
ri.ka.bi				*!	*	

(80) shows that the actual broken plural form *r.ka.bi* wins by satisfying all the constraints except for *MIN-σ, which is ranked lowest, and ANCHOR L/R, which is violated by all candidates that have -i as a suffix. The second candidate *ri.kab* is ruled out since it violates ALIGN-FM-RIGHT by infixing the feminine vowel as has already been seen in (79). The third candidate *rka.bi* loses by having a complex onset, which is a violation of *COMPLEX-M. the fourth candidate *ka.bi* loses because it violates MAX-IO by deleting an input segment. The last candidate *ri.ka.bi* inserts a vowel that was not in the input and is, thus, ruled out by violating DEP-IO.

[14] At the word level, ANCHOR L/R is ranked lower than it was at the stem level since it is violated by the actual broken plurals that have the suffix *-i*.

So far, we have seen how broken plural patterns CCVC and CCVCi are formed from the root CCC at both the stem level and word level. Now we turn to the word level analysis of the broken plurals derived from the root CCCC shown in (55b) above and whose stem level output form is CCVCC. (81) shows these forms with their word level input and surface broken plural forms.

(81)

Root	**Word Level Input**	**Word Level Output**	**Gloss**
fndq	fnadq	fnadəq	'hotel'
TbSl	TbaSl	TbaSəl	'vessel'
sllm	slalm	slaləm	'ladder'

The ranking proposed above for the broken plurals derived from the root CCC is not sufficient to account for the forms in (81). This can be seen from the tableau in (82).

(82) Word-level evaluation of /fnadq/

/fnadq/	**MAX-IO**	***COMPLEX-M**	**DEP-IO**	***MIN-σ**
☹ **f.na.dəq**			***!**	*
☞ **f.nad.q**				**

It can be seen in (82) that the actual broken plural surface form *f.na.dəq* loses by inserting the schwa which is a violation of the highly ranked constraint DEP-IO. The second candidate *f.nad.q*, on the other hand, wins because it does not violate any higher ranked constraint although it violates *MIN-σ which is the lowest constraint in ranking.

In order to fix this issue, a constraint that can be added is ALIGN-R-σ′. As proposed by Boudlal (2000), this constraint requires that the right edge of a word must be aligned with the right edge of a major syllable.

- **ALIGN-R-σ′**: The right edge of a word must be aligned with the right edge of a major syllable.

Major syllables in MA as mentioned above are CV, CVC, and CəC. This constraint was used by Boudlal to account for the position of the epenthesized schwa in verbs with triconsonantal roots. As seen in (83), the schwa is inserted between the second and third consonants because of the constraint ALIGN-R-σ′ which prevents the emergence of forms like **kətb* in which the rightmost syllable is a minor one. This tendency is seen in a large number of non-derived nouns and adjectives as well (84).

(83)

Root	**Stem**	**Gloss**
ktb	ktəb	'write'
Drb	Drəb	'hit'
gls	gləs	'sit down'

(84)

	Root	**Stem**	**Gloss**
Nouns	ktf	ktəf	'shoulder'
	sdr	sdər	'chest'
Adjectives	kħl	kħəl	'black'
	ħmq	ħməq	'crazy'

In order to rule out cases like *f.nad.q* in (82) in which a minor syllable is the rightmost syllable in the output broken plural forms, ALIGN-R-σ′ should be ranked higher than DEP-IO as shown in (85).

(85) Word-level evaluation of /fnadq/

/fnadq/	**ALIGN-R-σ′**	**DEP-IO**
☞ **f.na.dəq**		*****
f.nad.q	***!**	

Another ranking argument that should be included at this point is the one involving *MIN-σ and CONTIGUITY-CC. *MIN-σ is ranked higher than CONTIGUITY-CC. This ranking argument is shown in the tableau in (86).

(86) Word-level evaluation of /fnadq/

/fnadq/	*Min-σ	Contiguity-CC
☞ f.na.dəq	*	*
f.na.d.qə	**!	

Adding these ranking arguments into consideration, we would, so far, have the following ranking: ***Complex-m; Max-io; Align-r-σ′** >> **Dep-io** >> ***Min-σ** >> **Contiguity-CC**. (87) shows the tableau containing all these constraints and the possible candidates derived from the word level input CCVCC and through which the broken plural forms in (81) are formed.

(87) Word-level evaluation of /fnadq/

/fnadq/	*Complex-m	Max-io	Align-r-σ′	Dep-io	*Min-σ	Contiguity-CC
☞ f.na.dəq				*	*	*
f.nad.q			*!		**	
f.na.d.qə				*	**!	
f.nadq	*!				*	
f.nad		*!			*	
fə.na.dəq				**!		**

In (87), the actual broken plural form *f.na.dəq* wins by satisfying *Complex-m, Max-io, and Align-r-σ′. This candidate incurs a single violation to Dep-io by epenthesizing a schwa, *Min- σ by having a minor syllable, and Contiguity-CC by inserting a schwa between two adjacent consonants. The second candidate *f.nad.q* satisfies Dep-io by avoiding epenthesis but violates the higher ranked constraint Align-r-σ′, as has already been shown in (85) above, and, thus, loses. The third candidate *f.na.d.qə* does the same as the optimal one except for *Min- σ which is violated by this candidate twice since it has two minor syllables. The fourth candidate *f.nadq* is ruled out because it violates the highly ranked constraint *Complex-m by having a syllable with a complex coda. The fifth candidate *f.nad* violates Max-io by deleting an input segment and, therefore, loses. The sixth candidate *fə.na.dəq* satisfies the highly ranked constraints but loses, nevertheless, since it violates Dep-io twice by inserting two schwas.

It can be seen in the ranking in (87) that DEP-IO is ranked below *COMPLEX-M and MAX-IO. This was not the case at the stem level as DEP-IO was higher in ranking. This is due to the fact that insertion is avoided at the stem level, but, at the word level, high ranking *COMPLEX-M ensures outputs that conform with the syllable template of MA. CONTIGUITY-CC, which is a constraint that is ranked high at the stem level, is also reranked at the word level. It is shown in (87) that CONTIGUITY-CC is ranked lowest at the word level since all word level outputs of quadrisegmental roots like the one is (87) violate this constraint by epenthesizing a schwa between two adjacent consonants. *CCC, on the other hand, is not reranked as it cannot be violated at both the stem level and the word level, so it is ranked high at both levels.

5.3.3. The Roots CVC and CVCC

In this section, a word level OT analysis of the broken plurals derived from the roots that have vowels in them (CVC and CVCC) is presented. Let us first focus on the forms in (62a). (88) shows these forms with their word level input and output.

(88)

Root	**Word Level Input**	**Word Level Output**	**Gloss**
bir	biar	bjar	'well'
bit	biut	bjut	'room'
xal	xaal	xwal	'uncle'

The tableau in (89) shows that the word level ranking for triconsonantal root forms shown in (76) cannot account for these forms.

(89) Word-level evaluation of /biar/

/biar/	***COMPLEX-M**	**MAX-IO**	**DEP-IO**	***MIN-σ**
☹ **b.jar**				*
☞ **bi.ar**				

It can be seen in (89) that the second candidate *bi.ar* wins over the actual broken plural surface form *b.jar* by satisfying all constraints. The form *b.jar* violates *MIN-σ once by having a minor syllable and, thus, loses. This ranking does not work for these forms since they contain vowels in their roots and due to the existence of a glide as a surface segments that is not included in the word level input. The glide [j] seems to take the place of the input vowel /i/. The generalization that can be made is that if the input vowel is /i/, the glide that takes its place is [j]; if the vowel is /a/ or /u/, the glide is [w]. Therefore, we can say that the vowel of the root in these forms changes to a corresponding glide.

The existence of a glide in the forms in (88) can be explained through the interaction of two OT constraints: *MIN-σ and ONSET. While the former has already been introduced before, the latter requires for each syllable to have an onset consonant.

- **ONSET**: syllables must have onsets.

Ranking ONSET above *MIN-σ guarantees that the optimal candidate in (89) is the surface broken plural form and eliminates the candidate *bi.ar* as seen in (90). The latter loses by violating ONSET since it contains an onsetless syllable. The optimal candidate, however, satisfies ONSET, which is ranked higher, by changing the input vowel into a glide and, therefore, wins.

(90) Word-level evaluation of /biar/

/biar/	**ONSET**	***MIN-σ**
☞ **b.jar**		*
bi.ar	*!	

Combining all these constraints together, we come up with the following ranking: **ONSET; *COMPLEX-M; MAX-IO; DEP-IO >> *MIN-σ**. (91) is the tableau containing all these constraints and

the possible candidates derived from the word level input CVVC and through which the broken plural forms in (88) are formed[15].

(91) Word-level evaluation of /biar/

/biar/	ONSET	*COMPLEX-M	MAX-IO	DEP-IO	*MIN-σ
☞ b.jar					*
b.ja.r					**!
bi.ar	*!				
bjar		*!			
bar			*!		
bə.jar				*!	

Through this ranking, the actual broken plural form *b.jar* wins although it violates the lowest constraint in ranking *MIN-σ by having a minor syllable. The second candidate *b.ja.r* does the same as the optimal one as far as all the constraints are concerned but loses by having two minor syllables instead of one. The third candidate *bi.ar* loses by having an onsetless syllable, which is a violation of the highly ranked constraint ONSET. The fourth candidate *bjar* loses by violating *COMPLEX-M since it has a complex onset. The fifth and sixth candidates (*bar* and *bə.jar*) are ruled out because of deletion and insertion of input segments, which is a violation of MAX-IO and DEP-IO, respectively.

The ranking in (91) is also useful for the forms in (62b) that are derived from the root CVCC and whose word level input is CVVCC since these forms also contain vowels in their roots and, thus, have glides in their broken plural surface form as can be seen in (92).

(92)

Root	Word Level Input	Word Level Output	Gloss
xatm	xaatm	xwatəm	'ring'
BlaS	BlaaS	BlajəS	'place'
giTn	giaTn	gjaTən	'tent'

[15] It should be noted that this same ranking works for broken plurals of the form CCVC that have the glide /w/.

However, this ranking is still not sufficient as can be seen from the tableau in (93). This is due to the schwa epenthesis that takes place in these forms. This insertion is a violation of DEP-IO. The second candidate in (93), however, satisfies DEP-IO on the expense of having two minor syllables, and, since DEP-IO is ranked higher than *MIN-σ, this candidate wins.

(93) Word-level evaluation of /xaatm/

/xaatm/	ONSET	*COMPLEX-M	MAX-IO	DEP-IO	*MIN-σ
☹ x.wa.təm				*!	*
☞ x.wat.m					**

We have seen this situation in (82) with respect to the quadriconsonantal forms in (81). The problem can be solved in the same manner using the constraint ALIGN-R-σ′.

Ranking this constraint above DEP-IO will solve the problem in (93). Putting all constraints together, we come up with the following ranking: **ONSET; *COMPLEX-M; MAX-IO; ALIGN-R-σ′ >> DEP-IO >> *MIN-σ**. (94) shows the tableau containing all these constraints and the possible candidates derived from the word level input CVVCC and through which the broken plural forms in (92) are formed.

(94) Word-level evaluation of /xaatm/

/xaatm/	ONSET	*COMPLEX-M	MAX-IO	ALIGN-R-σ′	DEP-IO	*MIN-σ
☞ x.wa.təm					*	*
x.wa.tə.m					*	**!
x.wat.m				*!		**
xa.a.təm	*!				*	
xwa.təm		*!			*	*
xa.təm			*!		*	
xa.wa.təm					**!	

It can be seen in (94) that the proposed constraint ranking results in the form *x.wa.təm*, which is the actual broken plural surface form for the root *xatm*, being the optimal candidate although it

violates the two lowest constraints in ranking DEP-IO and *MIN-σ. The second candidate *x.wa.tə.m* does the same as the optimal one but violates *MIN-σ twice by having two minor syllables and is, thus, ruled out. The third candidate *x.wat.m* loses by incuring a violation to the highly ranked constraint ALIGN-R-σ′ since the rightmost syllable in this form is a minor syllable. The fourth candidate *xa.a.təm* has a syllable without an onset, which is a violation of ONSET, and so it is ruled out as well. The fifth candidate loses by having a complex onset, which is a violation of *COMPLEX-M. The sixth candidate violates MAX-IO, and, therefore, loses since the latter is ranked high. The last candidate loses because it violates DEP-IO twice by having two epenthesized segments in the output.

5.3.4. Conclusion

This section presented the word level OT analysis of the broken plural formation of the major broken plural patterns in MA. The first part of this section was devoted to the broken plurals derived from the roots CCCC and CCC, while the second part focused on the ones derived form the roots CVCC and CVC. The combined constraint ranking at the word level as far as broken plural formation in MA is concerned is the following: **ALIGN-FM-RIGHT >> ONSET; *COMPLEX-M; MAX-IO; ALIGN-R-σ′; ANCHOR L/R >> DEP-IO >> *MIN-σ >> CONTIGUITY-CC**. This ranking is able to generate the actual broken plural forms as shown in (95).

(95)

Word Level Inputs	**Word Level Outputs (broken plural forms)**
CCVC	CCVC
CCVCC	CCVC**ə**C
CVVC	C**C**VC
CVVCC	C**C**VC**ə**C

5.4. A Full Mapping of Some Broken Plural Forms

In the previous sections, we have seen the Stratal OT analysis of all broken plural major patterns in MA. This section will provide a full mapping of some examples of broken plural forms derived from different roots. First, we begin with quadriconsonantal roots CCCC. An example that we have seen above is the word *fnadəq* (‘hotels’) derived from the root *fndq*. Its derivation can be seen in (96).

(96)

a. Stem Level Evaluation

/fndq/ + /a/	MAX-IO	DEP-IO	*CCC	CONTIGUITY-CC	ALIGN-PL-RIGHT
☞ fnadq				*	**
fndqa			*!		
fndaq			*!	*	*
fnadqa		*!		*	
fna	*!*				

b. Word Level Evaluation

fnadq	*COMPLEX-M	MAX-IO	ALIGN-R-σ′	DEP-IO	*MIN-σ	CONTIGUITY-CC
☞ f.na.dəq				*	*	*
f.nad.q			*!		**	
f.na.d.qə				*	**!	
f.nadq	*!				*	
f.nad		*!			*	
fə.na.dəq				**!		**

Another broken plural patterns we have accounted for is the form CCVC, which is derived from the roots CCC or CVC. Let us take an example of how these plurals are derived. An example that we have analyzed above is the word *bjar* (‘wells’). The derivation of this broken plural using Stratal OT is illustrated in (97).

(97)

a. Stem Level Evaluation

/bir/ + /a/	DEP-IO	MAX-IO	ANCHOR L/R	ALIGN-PL-RIGHT
☞ biar				*
bair				**!
bira			*!	
bar		*!		*
baiar	*!			*

b. Word Level Evaluation

/biar/	ONSET	*COMPLEX-M	MAX-IO	DEP-IO	*MIN-σ
☞ b.jar					*
b.ja.r					**!
bi.ar	*!				
bjar		*!			
bar			*!		
bə.jar				*!	

A special broken plural form that has been seen is CCVCi. Broken plurals of this shape are derived from the feminine trisegmental root CCC or CVC. An example that was shown above is the word *rkabi* (‘knees’) derived from the root *rkb*. (98) shows the Stratal OT derivation of this broken plural form.

(98)

a. Stem Level Evaluation

/rkb/ + /a/	MAX-IO	DEP-IO	*CCC	ALIGN-PL-RIGHT
☞ rkab				*
rakb				**!
rkba			*!	
rkaba	*!			
rka		*!		

b. Word Level Evaluation

/rkab/ + /i/	ALIGN-FM-RIGHT	*COMPLEX-M	MAX-IO	DEP-IO	*MIN-σ
☞ r.ka.bi					*
ri.kab	*!				
rka.bi		*!			
ka.bi			*!		
ri.ka.bi				*!	

5.5. Against a Parallel Optimality Theory Analysis of Moroccan Arabic Broken Plural formation

As has been seen throughout this chapter, a Stratal OT analysis of MA broken plurals is able to account for the major broken plurals in MA. It was also suggested in the previous chapter that a parallel OT analysis would be insufficient to account for this phenomenon. This section shows how a hypothetical parallel OT analysis to MA broken plurals fails to secure the actual broken plural output forms. To show how this analysis is insufficient, the broken plurals derived from the quadrisegmental roots CXCC, shown in (99), are taken as an example. The constraints included in this analysis are the following: MAX-IO, DEP-IO, ALIGN-PL-RIGHT, ALIGN-R-σ′, and ANCHOR L/R.

(99)

	Root	Stem Level Output	Broken Plural	Gloss
a.	fndq	fnadq	fnadəq	‘hotel’
	sllm	slalm	slaləm	‘ladder’
b.	xatm	xaatm	xwatəm	‘ring’
	BlaS	BlaaS	BlajəS	‘place’

In this analysis, ALIGN-PL-RIGHT is ranked lowest in the ranking since it’s violated by the actual broken plural forms three times. It is ranked lower than DEP-IO as can be seen from the ranking argument in (100). Through this ranking, although the optimal candidate *f.na.dəq* violates

ALIGN-PL-RIGHT three times as opposed to *fə.nə.daq* which incures only a single violation to this constraints, the former wins by having only one epenthesized segment in the output, which was done twice by *fə.nə.daq*.

(100)

/fndq/ + /a/	DEP-IO	ALIGN-PL-RIGHT
☞ f.na.dəq	*	***
fə.nə.daq	**!	*

ALIGN-PL-RIGHT is also lower than ANCHOR L/R in the ranking; this can be seen from the ranking argument in (101). The latter shows how the optimal candidate *f.na.dəq* wins as it satisfies ANCHOR L/R by avoiding suffixation. The loser, however, suffixes the broken plural morpheme, which is a violation of ANCHOR L/R and, this, is ruled out.

(101)

/fndq/ + /a/	ANCHOR L/R	ALIGN-PL-RIGHT
☞ f.na.dəq		***
f.nəd.qa	*!	

DEP-IO is ranked lower than the remaining constraints, MAX-IO and ALIGN-R-σ′, as shown in (102) and (103), respectively.

(102)

/fndq/ + /a/	MAX-IO	DEP-IO
☞ f.na.dəq		*
f.daq	*!	

(103)

/fndq/ + /a/	ALIGN-R-σ′	DEP-IO
☞ f.na.dəq		*
f.nad.q	*!	

In (102), the optimal candidate *f.na.dəq* wins by satisfying MAX-IO which is ranked higher. MAX-IO is violated by the candidate *f.daq* which is, then, ruled out. In (103), although the second

candidate *f.nad.q* satisfies DEP-IO by avoiding epenthesis, it loses in comparison to the optimal candidate *f.na.dəq* by violating the highly ranked constraint ALIGN-R-σ′.

Taking all the constraints together, the combined constraint ranking would be the following: **MAX-IO; ALIGN-R-σ′ >> ANCHOR L/R; DEP-IO >> ALIGN-PL-RIGHT**. (104) is the tableau containing all these constraints and the possible candidates derived from the quadriconsonantal roots CCCC.

(104)

/fndq/ + /a/	MAX-IO	ALIGN-R-σ′	ANCHOR L/R	DEP-IO	ALIGN-PL-RIGHT
☞ f.na.dəq				*	***
fə.nə.daq				**!	*
f.daq	*!				*
f.nəd.qa			*!	*	
f.nad.q		*!			**

The ranking shown in (104) guarantees that the actual broken plural form *f.na.dəq* is the optimal one when it stands against the candidates shown in the tableau. However, there is a candidate that poses a problem for this ranking. This is shown in (105).

(105)

/fndq/ + /a/	MAX-IO	ALIGN-R-σ′	ANCHOR L/R	DEP-IO	ALIGN-PL-RIGHT
☹ f.na.dəq				*	**!*
☞ fən.daq				*	*

In (105), the candidate *fən.daq* does the same as the actual broken plural form *f.na.dəq* except for the constraint ALIGN-PL-RIGHT which is violated three times by *f.na.dəq* and only once by *fən.daq*.

A possible suggestion at this point is to add the constraint ALIGN-PL-LEFT.

- **ALIGN-PL-LEFT**: the plural vowel must be aligned with the left edge of the word.

If this constraint is higher than ALIGN-PL-RIGHT, the second candidate in (105) would lose, resulting in the actual broken plural form being the optimal candidate as can be seen in (106).

(106)

/fndq/ + /a/	ALIGN-PL-LEFT	ALIGN-PL-RIGHT
☞ f.na.dəq	**	***
fən.daq	***!*	*

In (106), the second candidate *fən.daq* loses since it has more violations of ALIGN-PL-LEFT than the optimal candidate *f.na.dəq*, and, since ALIGN-PL-LEFT is higher than ALIGN-PL-RIGHT in ranking, *fən.daq* is ruled out.

Adding the constraint ALIGN-PL-LEFT, nevertheless, is not sufficient to account for these broken plural forms. This can be seen in (107) that shows that another candidate would be the optimal one in case we exchange the positions of the schwa and the broken plural morpheme in the second candidate in (106).

(107)

/fndq/ + /a/	MAX-IO	ALIGN-R-σ′	ANCHOR L/R	DEP-IO	ALIGN-PL-LEFT	ALIGN-PL-RIGHT
☹ f.na.dəq				*	**!	***
☞ fan.dəq				*	*	****

The second candidate in (107) wins by having fewer violations of ALIGN-PL-LEFT than the actual broken plural form. This shows that no matter what the ranking argument between ALIGN-PL-LEFT and ALIGN-PL-RIGHT is, the actual broken plural form *f.na.dəq* would always lose either against *fən.daq* or *fan.dəq*.

What is even more problematic than these broken plural forms is the patterns involving glides shown in (99). An OT analysis of these forms makes use of the same constraints and constraint ranking proposed in (104). One ranking argument that should be added is the one involving DEP-IO and ANCHOR L/R. The latter must outrank the former in order for the actual broken plural form to be the optimal one as seen in (108).

(108)

/xatm/ + /a/	ANCHOR L/R	DEP-IO
☞ x.wa.təm		**
xat.ma	*!	

With this added ranking argument, the tableau for the derivation of the broken plural word *xwatəm* that is derived from the root *xatm* is shown in (109).

(109)

/xatm/ + /a/	MAX-IO	ALIGN-R-σ′	ANCHOR L/R	DEP-IO	ALIGN-PL-RIGHT
☞ x.wa.təm				**	***
xa.wa.təm				***!	***
x.tam	*!				*
xat.ma			*!		
x.wat.m		*!			**

The optimal candidate *x.wa.təm* in (109) wins by satisfying MAX-IO, ALIGN-R-σ′, and ANCHOR L/R although it violates DEP-IO twice by epenthesizing two segments. The second candidate *xa.wa.təm* does the same as the optimal one, but has more violations of DEP-IO than the optimal one and, thus, loses. The third candidate *x.tam* deletes an input vowel, which is a violation of the highly ranked constraint MAX-IO. The fourth candidate loses since it violates ANCHOR L/R by suffixing the broken plural vowel. The last candidate is also ruled out because of having a minor syllable in the rightmost edge of the word, which is a violation of ALIGN-R-σ′.

The ranking proposed in (109) shows that the actual broken plural form wins when compared to the other proposed candidates. If we add the candidate *xa.tam*, however, the actual broken plural form *x.wa.təm* would lose as can be seen in (110).

(110)

/xatm/ + /a/	MAX-IO	ALIGN-R-σ′	ANCHOR L/R	DEP-IO	ALIGN-PL-RIGHT
☹ x.wa.təm				**	***
☞ xa.tam					*

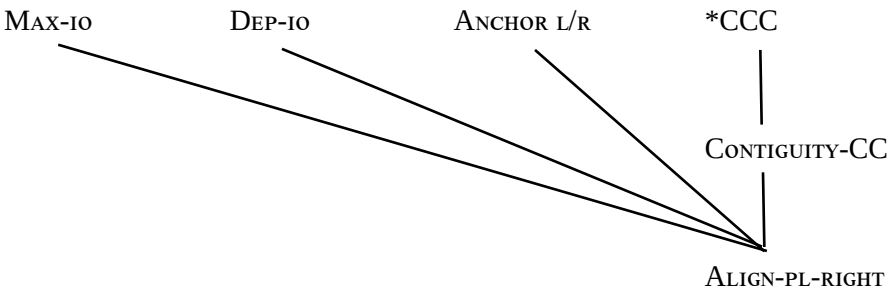
The candidate *xa.tam* wins by satisfying all constraints except for a single violation of ALIGN-PL-RIGHT, while the actual broken plural form *x.wa.təm* loses because of having two more violations of ALIGN-PL-RIGHT and violating DEP-IO twice. The winner in (110) is not only perfectly syllabified, but also avoids any modifications of the input. In other words, it satisfies any markedness and/or faithfulness constraints that can be proposed. All things considered, based on the two examples we have seen, a parallel OT analysis of MA broken plurals fails in comparison to the Stratal OT analysis proposed above.

5.6. Conclusion

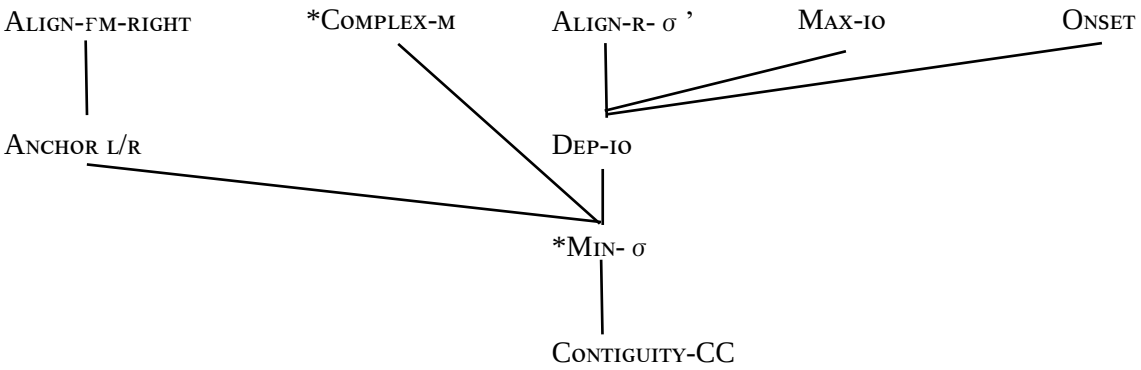
This chapter presented a Stratal OT analysis of the major broken plurals in MA. These include the broken plural patterns CCVC, CCVCi, and CCVCəC. We have seen that a Stratal OT approach to this phenomenon is more effective than a parallel one which proved to be insufficient in dealing with some major broken plural forms. With respect to the proposed Stratal OT analysis, a number of constraints have been used to derive the major broken plural forms in MA. The constraint ranking at the stem level is as follows: **MAX-IO; DEP-IO; ANCHOR L/R; *CCC >> CONTIGUITY-CC >> ALIGN-PL-RIGHT**. At the word level, we have seen that some constraints are reranked to account for syllabification that occurs at that level. The constraint ranking at the word level is the following: **ALIGN-FM-RIGHT; ONSET; *COMPLEX-M; MAX-IO; ALIGN-R-σ′ >> ANCHOR L/R; DEP-IO >> *MIN-σ >> CONTIGUITY-CC**. In (111), Hasse diagrams representing both the stem level and word level rankings are shown.

(111)

a. Stem Level Ranking



b. Word Level Ranking



Chapter 6: Conclusion

This thesis proposed an account for broken plural formation in MA. It has been demonstrated that the major productive broken plural patterns can be sufficiently accounted for using the framework of Stratal OT. Using this approach, an analysis of the formation of the major broken plural patterns in MA was proposed. In addition, this thesis highlighted the major drawbacks and limitations of the previous analyses proposed to account for broken plurals in CA and MA. It was shown that, due to the differences in the phonological systems of MA and CA, including differences in their vocalic systems and prosody that result from the influence that Berber has on MA, the analyses proposed for CA broken plurals do not work for all relevant MA broken plural forms. The Stratal OT analysis proposed, however, successfully accounts for the MA data.

The present thesis proposed a new view of Non-concatenative Morphology in the Arabic language. Using a cyclic approach like Stratal OT to account for a non-concatenative morphological process (i.e. broken plural formation) in MA paves the way for future research in Arabic morphophonology. One area of future research is the extension of this analysis to CA plural formation. It has been shown that McCarthy's (1997) account of CA broken plurals can be applied maximally to two broken plural patterns out of more than 30 existing patterns. This stems from the fact that, in a number of patterns, the broken plural output forms look very different from their corresponding singulars; thus, a unified analysis of all the major broken plural patterns in CA seemed impossible from the perspective of McCarthy. A Stratal OT view of broken pluralization in CA, however, has potential to provide a better account of this phenomenon since, in adopting such an approach, the input to broken pluralization —the root— will be similar for most patterns. Differences will be at the epenthesis and syllabification stage in which some broken plurals will be

dealt with in a different manner depending on the nature of the segments of the root and the existence of other processes that take place at the word level.

Second, Stratal OT can be used to account for other non-concatenative morphological processes in MA, one of which is diminutive formation. Diminutives share the same complexity and problematic issues we've seen with respect to broken plurals. In this non-concatenative process, a number of patterns are formed from a larger number of stem shapes. As was shown in this thesis concerning broken plurals, it is highly unpredictable which diminutive pattern a particular noun stem has. Therefore, adopting a cyclic approach in which diminutives are initially formed from their corresponding nominal roots and go through two levels, as is the case with broken plurals, has potential to account for the major patterns in diminutive formation. Such an account may be extended to cover other Arabic varieties spoken in other Arab countries.

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