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A STUDY OF THE PHONOTACTICS OF ASHT TOUZINE TARIFIYT DIALECT

by

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ABSTRACT

The present thesis investigates, from the point of view of the prosodic model (especially that in Selkirk (1984), the phonotactics of Asht Touzine Tarifiyt (henceforth ATT), a Berber variety spoken in the north-eastern part of Morocco. It attempts -based on a partly universal, partly language-specific algorithm- to determine the domain of the phonotactic conditions in ATT. It is found that this domain is the syllable exhibiting a branching onset (with two positions) and a complex rime (with three positions). Moreover, sonority indices drawn from the universal sonority hierarchy have been found useful in assigning syllabicity to segments and, therefore, accounting for segment organization within an ATT syllable.

The thesis also contributes to the on-going debate concerning the statement of phonotactic constraints both in studies of general nature and in those conducted on Berber proper. As concerns the first type of studies, the thesis tests the universally claimed Sonority Sequencing Generalization (SSG), whereby -within a syllable- segments are organized in conformity with a universal sonority hierarchy. The SSG is found to be only partially true of segment organization in ATT. As for studies on Berber phonotactics, the claim concerning the eligibility of all segments for syllabicity (i.e. vowels, sonorants, and obstruents can function as syllable nuclei) is tested

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and proved to be well-founded.

The present work is divied up into five chapters. Chapter I is concerned with the setting up of the phonemic inventory of the ATT variety. The relevant literature on syllable structure and phonotactic constraints is reviewed in chapter II. Chapter III deals with the syllabification rules operative in the variety under study. Segment~~s~~ organization in ATT is the subject of chapters IV and V. Finally, the results of the present investigation and some of its limitations are highlighted in the general conclusion.

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DEDICATION

This work is dedicated to:

-My mother and father

-All my friends and relatives

LIST OF TABLES AND FIGURES

Transcription Key

IPA	Our Transcription	Examples	Gloss
a	a	aman	'water'
i	i	iri	'neck'
u	u	su	'drink'
? ə	ə	ə	'particle, to be'
a:	a:	sa:s	'put down'
o:	o:	a~~h~~fo:	'hole'
e:	e:	aʒŝme:	'beard'
? a	a		
p	p	plancâ	'iron'
b	b	aɣmbuB	'face'
f	f	fif̂u	'thread'
β B	B	BaBa	'father'
m	m	mun	'go with'
t	t	atif̂i	'it will exist~~s~~'
θ t	θ	θaf̂a	'source of water'
d	d	adnas	'we'll come'
ɣ̂	ɣ̂	ɣ̂wf̂	'go back'
n	n	anu	'well of water'
ŋ	ŋ	iŋka	'he denied'
s	s	su	'drink'
z	z	zid	'go on'
ʃ	ŝ	iŝɣf̂	'he's busy'
ʒ	ẑ	aẑris	'frost'
l	l	lmalik	'king'
r	r	ru	'cry'

t͡ʃ	ĉ	plancâ	'iron'
d͡ʒ	ĵ	dḋĵ	'indignity'
j	j	jura	'he wrote'
J	y	iyra	'he baked'
ç	ç	içsi	'he lifted'
$ç^w$	$ç^w$	$aç^w$ɵm	'male'
k	k	kaBa:	'make do'
g	g	agr̂a	'property'
q	q	qδ̣u	'cut'
x	x	xns	'avoid'
ɣ	ɣ	ɣn:ẑ	'sing'
w	w	awi	'take'
ħ	ħ	ħaδa	'touch'
ʕ	ʒ	aʒr̂aw	'rug'
h	h	hna	'be in peace'

Pharyngealized segments are transcribed with a dot (.) underneath (e.g. δ̣u 'fly'). Geminate segments are transcribed as sequences of two segments when referring to their underlying status, and as long segments (C:) when referring to their phonetic realization in chapter . For convenience of analysis, they are represented as sequences of two identical segments in chapters IV and V, when they occur utterance (or word-) medially; utterance-initially, and utterance finally, they are represented as long segments (C:) to distinguish them from sequences of identical segments.

GENERAL INTRODUCTION

The present work is an attempt at analysing the sequential constraints governing segment organization in the Asht Touzine Tarifiyt variety (henceforth ATT) spoken in the north-eastern part of Morocco (see map p.4). The theoretical model utilized here is the autosegmental framework as conceived of in Selkirk (1982), (1984) (cf. Chap.II).

One of the purposes of the present study is to bring to light the various rules and conditions that enable the native speakers of ATT to distinguish between an acceptable sequence of segments and an unacceptable one. To this end, a syllabification algorithm based on current proposals concerning syllabification rules is worked out, and applied to ATT data.

Another purpose of this thesis is to test some universal claims made about phonotactic phenomena (viz. the sonority sequencing generalization, syllable constituency and phonotactic constraints, etc.) in works written within non-linear models of phonology (especially Selkirk (1982), (1984). As concerns Berber phonotactics, we examine and test hypotheses whereby any segment can be a syllabic peak (Dell and El Medlaoui (1985), (1988), etc.), and that the use of sonority indices (cf. Selkirk (Ibid)) together with the assignment of a place of articulation index to segments (cf. Boukous (1987)) allow for a straightforward formalization of generalizations on segment organization in natural languages.

The data on which the present analysis of Berber (ATT) phonotactics is based come from two sources: (a) our own intuitions as a native speaker of ATT, and (b) a steady core of four native speakers and many occasional language consultants. The procedure used is as follows: First, we provide forms based on our intuitions; second, we ask native speakers -using glosses in Moroccan Arabic- how they syllabify them. Their judgements were recorded as faithfully as we could.

This thesis is divided up into five chapters. Chapter one is concerned with the examination of the different occurrences of the segments of ATT and their distinctiveness in various contexts. Its aim is the setting up of the phonemic inventory of the variety under study.

In chapter two we give a fairly extensive review of the literature, available to us, on the study of phonotactics in some natural languages, Berber included. The task of this chapter is to shed light on the efficiency of the use of sonority indices and place of articulation indices in capturing significant generalizations on segment organization.

The object of chapter three is an attempt at formalizing the intuitions of the native speakers of ATT concerning acceptable and unacceptable syllable representations. Thus, a syllabification algorithm which -it is claimed here- enables these native speakers to scan strings of segments into syllables is elaborated in the same chapter.

Chapters four and five are directly concerned with the phonotactic constraints governing segment organization in ATT. The conditions that hold on the co-occurrence of segments in the onset constituent are the object of chapter four, while chapter five is concerned with the investigation of conditions on sequences of segments in the rime constituent.

Finally, a summary of the findings of our investigation and its implication for further research are provided in the general conclusion.

CHAPTER ONE

THE SEGMENTAL INVENTORY OF ATT

I.0 Introduction

Early works dealing with the phonology of Tarifiyt opted for a comparative approach. The major concern of Biarnay (I9I7) and Renisio (I932), for instance, is an attempt at constructing a general phonological system of Tarifiyt varieties. In spite of the ground-breaking achieved by these works, the absence of a systematic analysis and the adoption of a comparative approach have abscured some generalizations about individual varieties.

Commenting on these two works, Chtatou (I982:26) notes some deficiencies inherent to them. With respect to Biarnay (I9I7) he writes: [1]

> It [...] comprised a part which dealt with phonetics and phonology and in which a general phonemic inventory was given and certain phonological rules were discussed somewhat superficially. The analysis adopted in this work, however, did not stick to the de Saussurian practice whereby synchrony and diachrony are not mixed in a descriptive account.

Chtatou (Ibid), likening the limitations in Renisio (I932) to those observed in Biarnay (I9I7), also states: [2]

> What is said of Biarnay (I9I7) can also apply to Renisio's Etude sur les dialectes berbères des Beni Iznassen, du Rif et du Senhaja de Sraïr published in (I932). [...] This work, though packed with useful data, is very mediocre in as much as it reads as a grammar book of the "Teach-Yourself" variety.

Despite the deficiencies in these works, mentioned above, their major contribution resides in their providing of a phonetic description of sounds used in the varieties of Tarifiyt they dealt with, including the ATT variety. This, in itself, justifies the repeated reference that will be made to them throughout this chapter.

More recently, studies on Berber concentrated on individual varieties. For example, Saib (1976a) provides a phonological analysis of Ait Ndhir Tamazight. Chami (1979) deals with the phonology and morphology of the Iqrʒiyyen variety of Tarifiyt. Chtatou (1982) is concerned with the phonology of Iharassen Tarifiyt. El Medlaoui (1985) analyses the syllable structure and the syllabic segments of Imdlawn Tashelhiyt, and Boukous (1987) provides a detailed investigation of the phonotactics of the Tashelhiyt variety spoken in Agadir. It should be pointed out that these are but a few examples; other investigators will, undoubtedly, follow suit.

The only work carried out within the framework of generative phonology, and which dealt with a variety of Tarifiyt, is Chtatou (1982). The major difference between Chtatou's (Ibid) analysis and the present analysis is that whereas he posits eight underlying vowels (c.f. below) for the Iharassen Tarifiyt, we recognize only three underlying vowels for ATT. The two vowel systems are discussed below.

I.1 On the vowel system of Tarifiyt

Most of the arguments put forward by Chtatou (1982) in his discussion of the vowel system of Iharassen Tarifiyt (henceforth IT) can also be made for ATT. For this reason, a brief review of Chtatou (Ibid) is provided below before proceeding to the discussion of the vowel system of ATT. As said above (c.f., I.0), the major difference between the vowel system of IT as conceived of by Chtatou (1982), and the vowel system of ATT presented in I.1.2 below is that the former variety has eight underlying vowels: / i, a, u, e, o, ọ, ɑ, ạ, ọ / (where the dots indicate pharyngealization) and the latter (i.e. ATT) posits only three underlying vowels, namely / i, a, u / (for discussion, see below).

I.1.1 The vowel system of IT

Based on his examination of the various phonetic vowels of IT, Chtatou (1982:72) concludes that his native variety has the eight underlying vowels given above. The phonetic realization of these vowels and their context of occurence are given below (Chtatou, Ibid:72):[3]

(1) / i / ⟶ ị / —— C̣ —— (e.g. ð̣ṛịx̣ 'I climbed down'
i / Elsewhere (e.g. iri 'neck'
/ a / ⟶ ạ / —— C̣ —— (e.g. nḍạx̣ 'I threw'
a / elsewhere (e.g. anu 'well of water'

/ u / ⟶ ụ / —— C̣ —— (e.g. θ̣ụ 'fly')
u / elsewhere (e.g. fus 'hand')

/ e: / ⟶ ẹ: / —— C —— (e.g. sseδ̣ 'to help s.o dress')

e: / elsewhere (e.g. iqs... 'sandals')

/ a: / ⟶ ạ: / —— C̣ —— (e.g. nda 'I threw')
a: / elsewhere (e.g. tta: 'beg')

/ o: / ⟶ ọ: / —— C̣ —— (e.g. zọ: 'to kiss')
o: / elsewhere (e.g. θabro: 'lump of sugar')

/ ạ: / ⟶ ạ: / in all environments (e.g. fəkkạ: 'to think')
/ ọ: / ⟶ ọ: / in all environments (e.g.

Chtatou (Ibid) does not overlook the possibility of reducing the IT vowel system. His main arguments for including the other vowels (e:, a:, o:, ạ:, ọ:) as underlying, besides the three (i.e./ i, a, u /), long recognized by other Berberists (cf. Basset 1929; Chami, 1979), are: (a) overgeneralization, (b) lack of alternations, (c) lack of economy, and (d) diachronic/synchronic overlapping. These arguments are discussed in turn below.

a) <u>Overgeneralization</u>

Chtatou (1982:49) advances evidence for the existence of an underlying <u>r</u> in forms ending with phonetic long vowels by using the suffixing text:

(2)

Singular Noun	Singular Noun +suffix-a	Surface Form	Gloss
aŝbe:	aŝbe:+a	aŝbira	'Robe: this robe'
afa:	afa:+a	afara	'leaf: this leaf'

In (2), it is the liquid r which breaks the hiatus instead of the glide y, as in (3) below:

(3)

Singular Noun	Singular Noun +suffix-a	Surface Form	Gloss
ð̌ini	ð̌ini+a	ð̌iniya	'dates: these dates'
ifri	ifri+a	ifriya	'cave: this cave'

The suffixation of the demonstrative a to the forms in (3) results in the shortening of long vowels. Thus, the long vowel in the forms aŝbe: and afa: is shortened when the r surfaces in the phonetic forms. Chtatou (Ibid:52) explains this by writing:

> The occurence of the liquids r and ṛ at the surface and the shortening of the preceding vowel [...] proves unequivocally that the vowel segments e, ɑ, o, ạ, ọ are related to their counterparts ī, ā, ū.

This is why he goes further to consider the possibility of deriving the long vowels from the short ones "in the environment of r or ṛ provided they are not followed by a vowel":

(4) e: < ir
a: < ar
o: < ur
ạ: < aṛ
ọ: < uṛ

A process of vowel lengthening results in the dropping of r or ṛ, as shown below (Chtatou Ibid., p.53):

(5) Vowel Lengthening:

$$\begin{bmatrix} V \\ -\text{tense} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{tense} \end{bmatrix} \Big/ \underline{\quad\quad} \begin{bmatrix} +\text{son} \\ -\text{syl} \\ +\text{vib} \end{bmatrix} \begin{Bmatrix} [-\text{syll}] \\ \# \end{Bmatrix}$$

The following rule deletes the liquid r (or ṛ):

(6) R-deletion

$$\begin{bmatrix} +\text{son} \\ -\text{syll} \\ +\text{vib} \end{bmatrix} \longrightarrow \emptyset \Big/ \begin{bmatrix} V \\ +\text{tense} \end{bmatrix} \underline{\quad\quad} \begin{Bmatrix} [-\text{syll}] \\ \# \end{Bmatrix}$$

The rules in (5) and (6) are supplemented by the following low level phonetic rules as stated by Chtatou (Ibid.: 53):

(7)	i: ⟶ e	[æ]	before a consonant
		[ɛ:]	in final position
	a: ⟶ ɑ	[æ·ə]	
	u: ⟶ o	[ɔ̥·ə]	

This attempt at devising rules to account for the derivation of long vowels from sequences of short vowels and the liquid r or r faces the problem of overgeneralization, which makes such an analysis "too powerful and [...] prone to make wrong predictions" (Ibid:58).

The problem of overgeneralization is illustrated by forms which meet the structural description of rules (5) and (6) but do not undergo vowel lengthening and R-deletion; these forms are given below in (8).

(8)

Underlying Form	Surface Form	Gloss
aɣir	aɣir —X→ *aɣe:	'arm'
ayuẑir	ayuzir —X→ *ayuze:	'orphan'
ŝar	ŝar —X→ *ŝa:	'soil'
awar	awar —X→ *awa:	'speech'
ur	ur —X→ *o:	'heart'
afrfur	afərfur —X→ *afərfo:	'a type of couscous'

If the forms above undergo rules (5) and (6), the result will be ill-formed; as indicated by the asterisks on the surface forms in (8).

b) <u>lack of economy</u>

Chtatou (Ibid) discusses a possible solution to account for the forms in (8): it is to devise rule diacritics only for them. Thus, forms which are marked [+rule](5) will undergo rule (5); those marked [- rule] (5) will not.

That is, the forms in (8) above will all be marked [- rule] (5) and they will surface as attested in IT. The reason why such a solution is not efficient, according to Chtatou, is that there are too many forms like those in (8) in IT. Hence, it will be a very costly solution.

c) Lack of alternations

In addition to the problems of overgeneralization and lack of economy, Chtatou (Ibid.) adds the problem of 'lack of alternations' as further counter-evidence for positing three vowels underlyingly in IT. Thus, he rightly argues that there are forms with surface long vowels but there are no alternations to justify the existence of an r or ṛ at any level of their derivation. Consider the items in (9):

(9)

Forms with long vowels	Gloss
e:ðǎn	'wheat'
e:riẑ	'embers'
ẹ:ð̣	'to dress'
a:n	'flour'
ạ:ẓ	'to break'
o:θan	'orchard'

It should be noted that it is useless to attempt the suffixing test, because the long vowels are not word-final.

d) <u>Necessity of resorting to historical information</u>
<u>(Diachronic/Synchronic Overlapping)</u>

A diachronic analysis of the long vowels in IT will reveal the existence of an r or ṛ in the forms in (9). However, this account will not be of great help since it will be 'recapitulating the history of the dialect'.

Based on the arguments sketched above, Chtatou (Ibid.) opts for an underlying eight-vowel system for IT, namely: i, a, u, e:, a:, o:, ạ:, ọ:.

As said in the introduction to this section, we shall investigate the phonemic inventory of ATT along with a discussion of the arguments advanced by Chtatou (Ibid.).

I.1.2 <u>The vowel system of ATT</u>

All the vowels dealt with in the preceding section are attested in ATT, as shown by the data below:

(10)

Vowels	Illustrative Forms	Gloss
i	iri	'neck'
a	aman	'water'
u	ur	'heart'
e:	e:ð	'grain'
a:	a:n	'flour'
o:	aɣnzo:	'face'

ạ:	ạ:ẓ	'break'
ọ:	rfð̣ọ:	'breakfast'

Most of the arguments advanced by Chtatou (1982) in support of an eight-vowel-system can also be made for ATT. For example, any attempt to derive long vowels from sequences of short vowels +r or r̥ is faced by the problem of overgeneralization, since there are forms that display underlying short vowels +r or r which do not surface as long vowels . Some of these are in (11):

(11)	Underlying Form	Surface Form	Gloss
	aɣir	aɣir *aɣe:	'arm'
	amzir	amzir *amze:	'ironsmith'
	aɣjur	aɣjur *aɣjo:	'donkey'
	að̣ir	ạð̣ịṛ *ạð̣ẹ:	'grape'

In addition to the problem of overgeneralization, there is that of lack of alternations. That is, in ATT, too, there are forms with long vowels, but there are no alternations to justify that these long vowels result from sequences of short vowels +r or r:

(12)	Surface Forms	Gloss
	a:zu	'look for'
	a:ni	'add'
	asa:ðun	'mule'
	qa:qriw	'frog'

Obviously, the suffixing test will not help in identifying the presence of r in these forms: neither can the alternation singular/plural in the case of the last two examples above.

With respect to 'lack of economy', the costly solution proposed for IT would operate in the same way in ATT; that is, we can distinguish forms which undergo R-deletion from those which do not by the mechanism of rules of diacritics. For example, the form aɣir would be marked [-R-deletion] and it will correctly surface as aɣir . The form aðbir on the other hand, will be marked [+R-deletion] and will correctly surface as aðBe: .

However, allowing for a certain degree of abstractness in our analysis, and drawing a phonetically motivated distinction between the dropping r (i.e; / r /) and the non-dropping r (i.e. / r̂ /) (cf. Saib(1986:284-6)) will result in a simpler vowel system of ATT.

In spite of the counter-arguments reviewed so far, there remains a plausible solution which would allow us to postulate the basic Berber vowel system for ATT, namely the vowels: /i/, /a/, /u/. This solution takes into consideration two related facts in ATT: (a) the difference between the dropping r and the non-dropping one, and (b) the syllable environment of the dropping r.

Our solution also bases itself on an observation made by Renisio (I932). The author notes the existence of two non-pharyngealized liquids: r̲ and r̬ (our /r̂/ see fn.(2)) and observes that they are kept distinct by the native speakers of Tarifiyt. He writes: "Ce son [r̬] ne se confond pas avec r." and gives the following illustrative examples (Renisio (Ibid. p.22)):

(13)	ťisir̬a	'sandals'	ťisira	'molars'
	edder̬	'cover'	edder	'live'

(N.B.: ť̲= θ̲, r̬= r̲̂ in our notation)

Other examples to support the distinction r̲/r̲̂ in ATT are:

(14)	iðr̂a	'he's covered'	iðra	'it is stained'
	iɣra	'to be expensive'	iɣṛa	'he studied'
	ar̂i	'mount'	ari	'to write'

Phonetically, Renisio (I932) explains that the tongue vibrates less when producing r̲̂. We believe however, that it is the reverse; i.e. the tip of the tongue vibrates more when producing r̲̂ (cf. Sect. I.3 below) than when producing r̲.

More recently, El Medlaoui (I988a) emphasises the importance of such a distinction between the two liquids r̲ and r̲̂ in Guelaya (i.e. Iqərʒiyyen) Tarifiyt (See Map p. 4).

He explains that there are special assimilation processes that affect r̂ (his notation: ř) but not r. For example, a sequence /r̂t/ is realized as ĉĉ by a bidirectional (progressive and regressive) assimilation. In addition to this, the above distinction allows for a straightforward account of the R-deletion phenomenon. For this purpose, El Medlaoui formulates the following rule:

(15) / r / $\longrightarrow$ [:] $\overset{R}{\wedge}$_ ([:] = ⅄ ; R=rime)

Rule (15) contains the information that the vowel preceding r lengthens (cf. El Medlaoui (1985) for ⅄ or "Alif") as a result of the dropping r.

El Medlaoui's arguments hold also for ATT; thus, by adopting the distinction r / r̂, we will have a plausible solution for the vowel lengthening in ATT, which makes Rule (15), therefore, operative in ATT, as well as in Guelaya variety.

The forms which have no alternations to justify an underlying r will be represented with r at the underlying level as shown in (16) below:

(16)	Underlying Form		Surface Form	Gloss
	irð̌	$\longrightarrow$ Rule (15)	e:ð̌	'Grain of wheat'
	sirð̌	$\longrightarrow$ Rule (15)	se:ð̌	'wash'
	urθu	$\longrightarrow$ Rule (15)	o:θu	'orchard'

As can be seen above, however, R-deletion alone cannot account for the vowel lowering which accompanies vowel lengthening. For this reason, we postulate the following phonetic segment structure condition:

(17) If $\begin{bmatrix} V \\ +\text{tense} \end{bmatrix} \rightarrow$ then $\begin{bmatrix} -\text{high} \end{bmatrix}$

The vowel / a /, being the lowest on the vowel chart of ATT will only be lengthened.

In addition to the vowels dealt with above, pharyngealized short vowels are attested in ATT in pharyngealizing contexts, as illustrated in (18):[4]

(18)

Underlying Forms	Surface Forms	Gloss
ð̣u	ð̣ụ	'fly'
θaẓuĉ	θ̣ạẓụĉ̣	'khol'
θiṭ	θ̣ịṭ	'eye'

In conclusion, the underlying vowel system of ATT is:

(19)

i		u
	a	

The rule that derives long vowels from sequences of short vowels +r is reproduced below (cf. Rule (15)

(20) $/ r / \longrightarrow [:] \;\; \overset{R}{\wedge}\!\!\_ \quad ([:] = X \; ; \;$ R= rime$)$

The segment structure condition (17) is reproduced as (21):

$$(21) \quad \text{If} \begin{bmatrix} V \\ +\text{tense} \end{bmatrix} \rightarrow \text{then} \begin{bmatrix} -\text{high} \end{bmatrix}$$

Before closing this section on the vowel system, it should be pointed out that the issue of the schwa vowel is taken up at length in (Chap.III), where we deal with the syllable structure in ATT.

I.2 Glides

Equally problematic in Berber is the class of glides. An observation made by various phonologists (Guerssell (1986) and references cited there) is that glides do not constitute an independent class of phonemes; they are rather the [-syllabic] counterparts of their corresponding vowels (e.g. i is [+syllabic] and j is [-syllabic]; underlyingly, the two sounds belong to the same phoneme / I /). In other words, whether a phoneme is syllabic or not is determined by the place it occupies in a syllable: as a syllable nucleus, a glide is realized as a vowel; and as an element of the onset or coda, it is realized as a non-syllabic segment.

In ATT, however, the status of glides is not so straightforwardly deduced. To illustrate the complexity of this class of segments we provide the examples below:

(22) Underlying Form | Surface Form | Gloss

Underlying Form	Surface Form	Gloss
I+ura	jura	'he wrote'
I+ndu+It	indwit	'he jumped it'

The position of the underlined high vowels in (22) above in the syllable cannot explain why / I+ura / surfaces as jura and not as iwra . The same remark applies to the second form in (22) which does not surface as *indujt .

A second problem (with the alternation high vowel/ glide) has to do with the distribution of j and w. These segments are found in environments not adjacent to vowels; and being in such a position, they would wrongly surface as vowels. Their attested forms are illustrated in (23):

(23)

Surface Form	Gloss
θjma	'She/it is grown up'
asjmi	'baby'
ðwr̂	'go back'
wẑð	'be ready'

Faced with such a difficulty in predicting whether a high vocoid will surface as a vowel or as a glide, Guerssel (1986:1-12) provides a working solution to the problem of these segments in Ait Seghrouchen Tamazight. He proposes that some members of the high vocoids would be underlyingly attached to rime heads, and surface as high vowels. The others, which will not be attached to rime heads, will surface either as high vowels or as glides depending on their position in the syllable. Such a distinction, he explains, will not run counter to the observation that the status of high vocoids as glides or high vowels is strictly a function of syllable structure. That is, recognizing such a distinction at the underlying level "does not imply the necessity of the feature syllabic." (Guerssel (Ibid.: 1))

The status of high vocoids in ATT will be taken up in more detail in Chapter III where it is argued that there are at least three types of glides. For now, we shall provide the set of underlying glides in ATT and the context of occurence of each member of this set, which is illustrated by the data in (24):

(24)	Initial Position	Medial Position	Final Position
j:	juza 'he skinned'	θajaẓa 'ploughing'	afraj 'fence'
w:	walu 'nothing'	θwar̂at 'once'	aht:aw 'a ṛug'
j::	------	θaj:a 'female slave'	-------
w::	w:θ 'hit'	θaw:a:θ 'a door'	-------

In conclusion, the four segments: j, w, jj, ww are considered as underlying phonemes in ATT. Further discussion in support of their underlying status is given in Chapter III.

I.3. Liquids

Historically, the class of liquids in Tarifiyt, the ATT variety included, is highly affected by borrowings (See I.I.1 for a discussion of r and r̂). The liquids l and r are realized as r̂ and r respectively in Arabic loan words. This is illustrated in (25):

(25)

Arabic	ATT	Gloss
lmuħal	r̂muħar̂	'impossibility'
waqila	waqir̂a	'maybe'
ləqləm	r̂ɑr̂m	'pen'
lwəqt	r̂wqt	'time'
lmaraḍ	r̂maraḍ	'illness'

The sounds r and ṛ are deleted in Arabic loan words when they occur word (syllable) finally as shown in (26):

(26)

Arabic	ATT	Gloss
nəẑ:ar	anẑ:a:	'carpenter'
xəd:ar	ax d:a:	'greengrocer'
lxir	r̂xe:	'goodness'
lʒṭur	r̂ʒto:	'spices'

The geminate /ll/ in Arabic loan words is sometimes realized as the affricate ĵ (cf. Saib (1986) for details) as shown in (27):

(27)

Arabic	ATT	Gloss
qəl:əb	qr̂B	'check, taste'
xəl:əṭ	xr̂ð	'mix'

After these notes on liquids in Arabic loan words, we turn to consider their phonemic status.

a) The case of /l/ and /ll/

The lateral l and its geminate counterpart ll are present in a few instances in ATT. This is illustrated in the examples in (28):

(28)

	Initial Position	Medial Position	Final Position
l:	lala 'chase'	tlʒ 'desert' mlls 'smooth'	lmal 'money'
ll:	————		————

The forms lala and tlʒ may be native ones whereas lmal and mlls are Arabic loanwords.

The two liquids l and ll never contrast with their vibrating correspondents r̂ and r̂r̂. Yet, in view of forms like those in (28) and (29), it is difficult to set up rules accounting for the derivation of r̂ from /l/ and r̂: from /ll/.

b) The case of /ḷ/ and /ḷḷ/

The pharyngealized lateral liquids ḷ and ḷḷ are found in a few instances, mainly in words with religious connotations (cf. Chtatou (1982)), and loan words from European languages (primarily Spanish). This is illustrated in (29):

(29)	Initial Position		Medial Position		Final Position
l:	lamba	'torch'	lβala	'spade'	————
ll:	llah	'Allah'	il:.l:ah	'but Allah	————

In view of the scarcity of forms with lateral liquids, it is difficult, if not impossible, to find instances where pharyngealized and non-pharyngealized variants of this class of segments contrast with each other.

c) The case of /r/ and /rr/

r is attested in pre-vocalic position where it functions as the onset of the syllable in which it occurs. This is why it is not attested word finally in (30) below:

(30)	Initial Position		Medial Position		Final Position
r	ru	'cry'	ari	'write'	————
	rass	'keep sheep'	iri	'neck'	————

The geminate correspondent of r i.e. rr, is attested in very few forms in ATT, as the forms in (31) below indicate:

(31)

Initial position	Medial Position		Final Position	
————	Bar:a	'out'	r̂Bar:	'earth'
————	ar:as	'give him back'	ar:	'give back'

(The geminate rr in the last forms (r̂Bar:, ar:) might be more accurately transcribed as r̂:).

The opposition l / r̂ is attested in one single pair in ATT, namely in lmal 'money' vs. r̂mar̂ 'animals' (Chami (1979:83)).

d) The case of /ṛ/ and /ṛṛ/

The forms below, in (32), show that /ṛ/ occurs word-initially and word-medially, whereas its geminate correspondent occurs only word-medially (cf. Rule (15) for R-deletion):

(32)

	Initial Position		Medial Position		Final Position
ṛ:	ṛaqq	'earth'	/aṛẓ/ a:z	'break'	————
			aṛu	'give birth'	————
ṛṛ:	————		aṛ:uð	'clothes'	————
	————		jaṛ:z	'it is broken'	————

e) The case of /r̂/:

This liquid is found in all positions in ATT as illustrated by the forms given in (33) below:

(33)

Initial Position		Medial Position		Final Position	
r̂mwaẑ	'waves'	ir̂i	'to be'	ʒð̌r̂	'repair'
r̂ur̂uf	'thousands'	θir̂mȩt	'skin'	indr̂	'he shook'

The geminate correspondent of r̂ (i.e. r̂r̂) is not found in ATT forms. In the intensive formation of the forms below, r̂ is not realized as r̂r̂, as is the case with other forms:

(34)

Underlying Forms	Intensive Formation		Gloss
ʒẑn	ʒẑ:n		'to step'
ʒð̌r̂	ʒd:r̂		'repair'
mr̂ŝ	mĵŝ	*mr̂:ŝ	'get married'
qr̂b	qĵB	*qr̂:B	'reverse'

A comparison of the forms in (34) with those in (27) reveals the relation r̂: ll: ĵ (cf. Chtatou (1982) for details on the history of this derivation and a synchronic account of these alternations).

The pharyngealized ṛ̂ is attested in pharyngealizing contexts, as shown by the data below:

(35)

Underlying Forms	Intensive Formation	Gloss
arð̣̌r̂	ạ:ð̣̌ṛ̂ /a:ṭṭʕ	'borrow'
indḍr̂	ịṇḍṛ̂ /inṭṭeʕ	'he is bu~~r~~ried'

The pharyngealized <u>ṛ̂</u> will not be considered as an independent phoneme of ATT, which is also the case of the geminate <u>ṛ̂ṛ̂</u>.

To sum up this section on liquids, the following segments are recognized as underlying phonemes in ATT: <u>l</u>, <u>ḷ</u>, <u>ll</u>, <u>ḷḷ</u>, <u>r</u>, <u>ṛ</u>, <u>rr</u>, <u>r̂</u>, <u>ṛṛ</u>.

I.4. Nasals:

The single nasals (<u>m</u> and <u>n</u>) and their geminate counterparts (<u>mm</u> and <u>nn</u>) are attested in all environments in ATT. Consider the data in (36):

(36)	Initial Position		Medial Position		Final Position	
<u>m</u>:	mar̂a	'if'	θmunit	'company'	isr̂m	'he's a Muslim'
	mr̂mi	'when'	θmr̂s	'to marry'	asr̂m	'fish'
<u>mm</u>:	m:ar̂	'show; int'	im:uθ	'he died'	iš m:	'he smelt'
	m:θ	'die'	θam:nt	'honey'	s:m:	'poison'
<u>n</u>:	nix	'or'	anu	'well'	imun	'he went with'
<u>nn</u>:	n:an	'they said'	θn:uɣ	'trapped. fem'	iħin:	'he sympathized'
	n:x	'ours'	in:a	'he said'		

The four nasal segments are pharyngealized in the context of pharyngeals, as shown in (37)

(37)	Underlying Form	Surface Form	Gloss
	θmiṭ	θ̣ṃịṭ	'navel'
	immuṛɣs	ịṃ:ọ:ɣ̣ṣ	'he was stifled'

unuɣ	unuɣ	'act of going round'

The single nasals m and n are subject to various assimilatory processes, among which we can mention the assimilation of m to n and the total assimilation of n to a following obstruent. These instances of assimilation are exemplified in (38) and (39):

(38)

Underlying Form	Surface Form	Gloss
θ+aqmmum+θ	θaqm:unt	'mouth: little mouth'
θ+ɣanim+θ	θɣanint	'cane: little cane'

(39)

Underlying Form	Surface Form	Gloss
n#mimunt	m:imunt	'of Mimunt'
n#karim	k:arim	'of Karim'
n#qada	q:ada	'of Kada'
n#xalid	x:alid	'of Khalid'
n#ħamid	ħ:amid	'of Hamid'

(N.B.: this n is the possessive marker in Berber)

As can be seen in the forms in (39) above, n (the possessive marker) totally assimilates to a following obstruent. Furthermore, when it is prefixed to nouns with an initial vowel, it undergoes a process of (labio-) velarization in ATT. This is illustrated in (40):

(40)

	Underlying Form	Surface Form	Gloss
a	n#aɣjur	ŋʷɣjur	'of the donkey'
	n#aman	ŋʷaman	'of the water'
	n#aθmun	ŋʷθmun	'of the haystuck'
b	n#iri	ŋiri	'of the neck'
	n#if̂m	ŋif̂m	'of the skin'
	n#ifri	ŋifri	'of the holé'

In the forms in (40a) the possessive marker is prefixed to forms with a low vowel, ~~whereas in the forms~~ in (40b), it is prefixed to forms with an initial front high vowel.

Another characteristic of the genetive marker is its deletion when prefixed to forms more than two syllables long:

(41)

Underlying Form	Surface Form	Gloss
n#aʒddis	uʒd:is	'of the stomach'
n#arumi	urumi	'of the Christian'

The labiovelar ŋŋʷ is also attested in ATT in the same environment as the dental nasal nn:

(42)

Forms	Gloss
in:a	'he said'
iŋ:ʷa	'it is cooked'

θn:am	'you. pl. said'
θŋ:^{w}am	'you are ripe'

The segment <u>ŋ:^{w}</u> cannot be derived from the sequence <u>nnw</u> , since this sequence is attested in other forms in ATT, as illustrated by the data below:

(43)	<u>Forms</u>	<u>Gloss</u>
	n:waða:	'glasses'
	n:wawe:	'flowers'
	n:waʒa:	'messing around'

The labio-velar <u>ŋ:^{w}</u> is recognized as an independent phoneme of ATT.

The nasal segments recognized as phonemes of ATT are: <u>n</u>, <u>nn</u>, <u>m</u>, <u>mm</u>, <u>ŋŋ^{w}</u>.

I.5 <u>Obstruents</u>

Berber varieties of the Rif are described in various works (e.g. Biarnay (1917); Basset (1952); Saib (1974); Chami (1979); Chtatou (1982); etc.) as having a tendency towards spirantization. This observation is supported by data from ATT, and other Riffian varieties. Yet, the discussion below shows that it is difficult to formalize spirantization rules to derive the [+cont] segments from their [-cont] correspondents. A second observation about the consonantal system of Tarifiyt in general is its complexity because of the presence therein of non-native phonemes. This complexity is illustrated by segments such as p which is restricted to Spanish loan words in ATT. We present, below, the obstruents that exist in ATT, according to their place of articulation.

a) Labials

(i) The case of p / pp

These two sounds are restricted to Spanish loan words, as shown by the data in (44) (cf. Chami (1979:45)):

(44) ATT	Spanish Origin	Gloss
planĉa	plancha	'iron'
sp:iṭa:	hospital	'hospital'
p̂pakij:θ	paquete	'box'
asp:anju	hispañol	'Spanish'

As can be observed in the data above, the geminate p: corresponds to the Spanish single /p/. In view of the limited occurences and the functional load of the segments p and p:, these segments are not considered as phonemes of ATT.

(ii) The case of b/ bb

Except after the nasal m, the labial b is realized as B; and the geminate bb is realized as b: in all contexts:

(45)

Underlying Form	Surface Form	Gloss
barra	Bar:a	'out'
aɣmbub	aɣmbuB	'face'
ibbuhr̂i	ib:uhr̂i	'he is mad'
r̂qbb	r̂qb:	'hood'

Pharyngealized B and b: are attested in the context of pharyngeals, as shown in (46):

(46)

Underlying Form	Surface Form	Gloss
ibδa	ibδa	'he divided'
batr̂	Batr̂	'gratis'
ibbuzzr̂	ib:uz:r̂	'he lay down'
sbbar	sb:a:	'console'

A further note about the segment b is its loss of the features [-cont] and [+ voice] before the voiceless dentals t or θ:

(47)

Underlying Form	Surface Form	Gloss
θ+aqrab+θ	θaqrafθ	'small bag'
θ+aɣmbub+θ	θaɣmbufθ	'small face'

(iii) The case of f / ff

These two sounds are widely attested in ATT. They occur word-initially, word-medially and word-finally, as can be seen in (48):

(48)

	Initial Position		Medial Position		Final Position	
f:	fuð	'knee'	afa:	'leaf'	f̂qf	'hit'
	fafa	'search'	ifri	'cave'	af	'to find'
ff:	f:ɣ	'go out'	θf:uð	'she's thirsty'	ituf:	'it is getting wet'
	f:afa:n	'they flew'	θaf:a	'stack of hay'	ikf:	'he farted'

Both f and ff are pharyngealized in pharyngealizing contexts, as illustrated below:

(49)

Underlying Form	Surface Form	Gloss
i+faṛð	ịf̣ạ:ð̣	'he swept'
θ+ffẓ	θ̣f̣:ẓ	'she chewed'

A final note about f is its acquisition of the feature [+voice] and its loss of the labio-dental articulation, when it occurs before the voiced dental stop /d/:

(50)

Underlying Form	Surface Form	Gloss
i+ṭṭf#d	ịṭ:Ḅḍ	'he caught (for us)'

This assimilation is subject to a syllable structure condition, namely that both f and d should belong to the same syllable (in the coda). Otherwise, the above observation would be an overgeneralization; witness the example below:

(51)	Underlying Form	Surface Form	Gloss
a)	~~i~~ttf # duru	it:f‿duru	'he caught fifty cents'
but			
b)	~~i~~ttf+d#uru	it:Bd‿uru	'he caught a handful of sth.'

To conclude, the labial segments dealt with above, and which are recognized as underlying phonemes in ATT are the following: b, bb, f, and ff.

b) Dentals

The segments investigated in this section are: t, d, θ, ð, ṭ, ḍ, θ̣, ð̣, t:, d:, ṭ:, ḍ:. It is argued below that all these segments are phonemes of ATT, except for the pharyngealized θ̣, which is attested exclusively in pharyngealizing contexts.

The data in (52) below show that the feminine marker /t/ and the /d/ in the future particle /ad/ are realized as θ and ð respectively (vowel alternations are disregarded):

(52)	Underlying Forms	Surface Form	Gloss
	t+ari	θura	'she wrote'

t+agi	θugi	'she refused'
ad#i+rah	aðirah	'he'll go'
ad#i+xzar	aðixza:	'he'll look'

The spirants in the phonetic forms in (52) can easily be accounted for by a spirantization rule. Yet, there are other forms in ATT where the segments in question surface as [-cont]. These are given in (53) below:

(53)	tari	'she mounts'
	trah	'she goes'
	xza:d	'look here'
	ndud	'jump here'

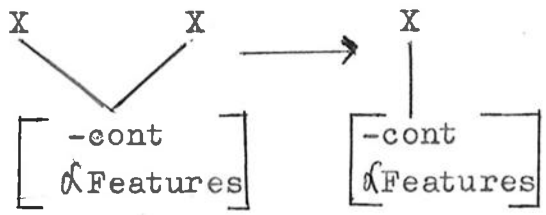
The segment t in (53) is the Intensive Formation marker and the segment d is the directional particle. A plausible solution to account for the different behaviour of the [-cont] segments t and d is to posit the Intensive Formation marker and the directional particle as underlying geminates, which will be reduced by a geminate contraction rule (cf. Saib, 1974; Chtatou, 1982). Hence, the underlying representations of the forms in (53) would be those in (54) below:

(54) <u>Underlying Forms</u>

tt#ari
tt#rah
xzar#dd
ndu#dd

The geminate contraction rule, that would reduce lexical geminates such as /tt/ and /dd/, would account for the forms in (54) above, and yield the attested surface forms in (53). This rule might be formulated as in (55) below:[5]

(55) Geminate Contraction



The rule in (55) above would yield the corresponding surface forms to those in (54) above. The former are reproduced in (56) for ease of reference:

(56) Underlying Forms	Surface Forms	Gloss
tt ar̂i	tar̂i	'she mounts Int.'
tt rah	trah	'she goes Int.'
xzar dd	xza:d	'look here'
ndu dd	nḍuḍ	'jump here'

Positing t and d as underlying geminates provides an explanation for their non-spirantization. Yet, rule (55) will apply to forms like those in (57) below and yield unacceptable results:

(57) Underlying Forms	Surface Forms	Gloss
ttamara	tamara	'hard work'
ttilawa	tilawa	'coursebook'

dduħ	duħ	'cradle'
ddur̂i	dur̂i	'cover'

A comparison of the forms in (57) with those in (54) uncovers a major difference between the two sets of geminates; those in (54) are separated from the morpheme they are prefixed to by a morpheme boundary, while those in (57) are part of the morpheme they occur in. This suggests that by constraining rule (55) so that it will not apply to the geminates in (57), it might yield the attested forms in ATT. The proposed constraint is formulated in the version of rule (55) provided in (58) below:

(58) $$\begin{bmatrix} X \quad\quad X \\ \diagdown\;\diagup \\ -\text{cont} \\ \alpha\ \text{Features} \end{bmatrix} \rightarrow \begin{array}{c} X \\ | \\ \begin{bmatrix} -\text{cont} \\ \alpha\ \text{Features} \end{bmatrix} \end{array}$$

The rule in (58) contains the information that the geminates to be reduced are those which have one morphemic function. As such, the rule in question will not apply to the sequences of identical segments (<u>d</u> <u>d</u>) in the forms in (59) below:

(59) Underlying Form	Surface Form	Gloss
abrid#d#amqqran	abrid:amq:ran	'the road is big'

The sequence <u>d d</u> in the example in (59) surfaces as a geminate since it does not meet the structural description of rule (58) which specifies that the geminates to be reduced must have one morphemic function (i.e., its members must function as a morpheme).

However, there are other forms in ATT where ~~sequences~~ of identical segments are reduced, as shown below:

(60) <u>Surface Forms</u> <u>Gloss</u>

adnas	'we'll come'
adiʒqB	'he'll come back'
adihwa	'he'll come down'

The segment <u>d</u> in each of the above forms is not spirantized, because it is the realization of underlying sequences of identical segments:

(61) <u>Underlying Forms</u>

ad#dd#n+as

ad#dd#i+ʒqb

ad#dd#i+hwa

One would expect the sequences d#dd to surface as a geminate <u>d:</u> since they do not meet the structural description of rule (58) above. Yet, as can be seen in (60), these sequences are also subject to the rule in (58). This suggests that the rule in question needs to be reformulated in such a way as to account for the sequences in question. For example, it would be possible to make rule (58) apply to identical (underlying) sequences of segments. Yet, one would still have to distinguish between the sequences of identical segments in (59) and those in (61).[6]

It seems that there is a historical process of geminate reduction that has applied to the Intensive Formation marker tt and the directional particle dd, but not to other classes of **lexical** geminates (cf. (57) above).

For the purposes of the present section, and seeing that the analysis of segment organization presented in Chapters IV and V will take into account both [-cont] and [+cont] segments, and because of the complexity of the issue at hand, we include both types of segments in the phonemic inventory of ATT, i.e. t, d, θ, and ð.

The pharyngealized counterparts of t and d are also included in the ATT phonemic inventory. Their status as phonemes is supported by the data in (62):

(62)	atawṛ	'betting'	atawn	'they'll take her'
	xðmit	'do it'	xθmit	'on the navel'
	ndu	'become butter milk'	ndu	'jump'

Pharyngealized θ is attested in forms with an underlying pharyngeal, whereas ð is attested also in forms where no other pharyngeal segment occurs:

(63)	Underlying Forms	Surface Forms	Gloss
	θiṭ	θit	'eye'
	θaṛwa	θa:wa	'progeny'
	ðaṛ	ða:	'leg'

ð̣að̣	ð̣að̣	'finger'
ð̣ʊ	ð̣u	'fly'

The data above testify to the observation that <u>ð̣</u> is an underlying pharyngeal in ATT, whereas <u>θ</u> is derived by rule. This gap in the consonantal system of ATT might be a direct cause of Arabic loan words, since in Arabic, there is an underlying pharyngeal <u>ð̣</u> but no underlying pharyngeal <u>θ̣</u>.

The dental geminates <u>tt</u>, <u>dd</u> and their pharyngealized counterparts are phonemes of ATT. Their phonemic status is supported by the data in (64).

(64)	<u>Initial Position</u>		<u>Medial Position</u>		<u>Final Position</u>	
<u>tt</u> :	t:a:	'beg'	qt:aʕa	'kind of snake'	———	
<u>dd</u> :	d:a	'live'	axd:am	'worker'	Bd:	'stand up'
<u>ṭṭ</u> :	ṭ:a:f	'piece'	xṭ:a:	'chose'		
<u>ḍḍ</u> :	ḍ:a:θ	'small leg'	axḍ:a:	'greengrocer'		

c) <u>Alveolars</u>

(i) <u>The case of s, ss, ṣ, ṣṣ, z, zz, ẓ, ẓẓ</u>

Alveolar fricatives are attested in various contexts, as shown in (65) below:

(65)	Initial Position		Medial Position		Final Position	
s:	sa:s	'put down'	asɣnu	'clouds'	asnus	'little donkey'
s::	s:awar̂	'speak'	θusuθ	'a cough'	iqs:	'he cut'
ṣ:	ṣa:wθ	'to thresh'	ṣBa:	'be patient'	ið̌ṣ	'sleep'
ṣ::	ṣ:ɣð̌	'shut up'	iṣ:uð̌	'he blew'	r̂gṣ:	'chops'
z:	zr̂i	'skrew'	izan	'flies'	imz	'thumb'
z::	z:in	'beauty'	iz:a:n	'they are ahead'	inhz:	'he moved'
ẓ:	ẓa:	'see'	iẓi	'gall'	r̂Bẓ	'to crash'
ẓ::	ẓ:i	'to milk'	iẓ:r̂	'he lied down'	r̂Bẓ:	'little boy'

These eight alveolar fricatives are all members of the ATT phonemic inventory.

d) Affricates (Prepalatals):

This class of segments comprises the voiceless alveolar affricate ĉ and its voiced correspondent ĵ. The first of these is attested mainly in Spanish loan-words. The second is attested in native forms as well as Arabic loan-words:

(66)	a. Initial Position		b. Medial Position		c. Final Position	
ĉ:	ĉikli	'Chewing gum'	quĉi	'car'	θuĉ	'small heart'
	ĉambi	'biscuits'	apinĉa:	'a puncture'	θað̌xuĉ	'small hole'
	ĉam:a:	'ball'	planĉa	'iron'	θaɣjuĉ	'she-donkey'

The forms in (66a-b) are all Spanish loan-words. In the forms in (66c) the voiceless affricate is the surface realization of the sequence $\underline{\hat{r}t}$, or $\underline{\hat{r}\theta}$, as shown by the underlying representation of these forms, given in (67) below:

(67) θ+a juȓ+θ   θ+uȓ+θ   θ+aðxuȓ+θ

The voiced correspondent of ĉ is attested in all environments, as illustrated below:

(68) a. <u>Initial Position</u>		b. <u>Medial Position</u>		c. <u>Final Position</u>	
ĵan	'they exist'	aBĵaʒ	'mud'	sðahĵ	'deserve'
ĵuz	'almonds'	aĵi	'brain'	ḍ;ĵ	'indignity'

In (68c) and in the second form in (68a) $\underline{\hat{j}}$ is the realization of <u>ll</u> in Arabic loan-words:

(69.) <u>Arabic Forms</u>	<u>ATT</u>	<u>Gloss</u>
l:uz	ĵuz	'almonds'
stahəl:	sðahĵ	'deserve'
dʒəl:	d:ĵ	'indignity'

$\underline{\hat{j}}$ is also the phonetic realization of the geminate /ȓȓ/: (examples taken from Chtatou (1982:133)):

(70)	Unmarked Form	Intensive Form	Gloss
	qr̂a	qĵa	'to fry'
	qrʒ	qĵʒ	'to uproot'
	hr̂ŝ	hĵŝ	'to get sick'
	mr̂ŝ	mĵŝ	'to get married'

Counter-evidence to the possibility of positing an underlying /r̂r̂/ to account for the occurences of ĵ is provided by forms like those in (68) above (cf. Chtatou (Ibid:135). The data and the discussion above suggest that it may not be a far-fetched solution to include the voiced affricate in the phonemic inventory of ATT, and not its voiceless correspondent (cf. Chtatou (Ibid) for a similar conclusion). However, such a solution will have to treat Spanish loan-words differently from native forms. For the purposes of the present section, ĉ and ĵ are considered as two independent phonemes of ATT.

e) Palato-alveolars:

(i) The case of ŝ, ẑ, ŝŝ, ẑẑ:

The phonemic status of the above four fricatives is supported by the data in (71):

(71)

	Initial Position		Medial Position		Final Position	
ŝ:	ŝk:	'doubt'	iŝa	'for sth.'	mr̂ŝ	'marry'
ŝŝ:	ŝ:θ	'eat. pl'	iŝɣr̂	'he's busy'	xBŝ	'scratched'
	ŝ:aθ	'hit. Int'	iŝ:ɣr̂	'for the work'	inŝ:	'for me'
ẑ	ẑa:	'between'	iẑði	'sand'	iẑ	'one'
	ẑn	'sleep'	aẑris	'frost'	ɣa:nẑ	'over there'
ẑẑ:	ẑ:an	'sleep, Int'	aẑ:r̂	'be a widow'	iẑ:	'type of tree'
	ẑ:nn	'jinni'	iẑ:n	'one'	siẑ:	'lean over'

The four palatal-alveolar fricatives discussed above are all members of the phonemic inventory of ATT, whereas their pharyngealized counterparts are derived by rule as shown in the data in (72):

(72)

	Initial Position		Medial Position		Final Position	
ŝ:	ṣ̂ạ:ð̣	'require'	iḍ:uhṣ̂ạ:	'he's deaf'	ʝạ:ṃṣ̂	'he winked'
ẑ:	ẓ̂ạṛ:	'drag'	ạẓ̂ạ:ð̣ị	'chaos'		
ŝŝ:	ṣ̂:ọ:	'to fill'	iḄṣ̂:ạ:	'he gave good news'		
ẑẑ:	ẓ̂:ð̣	'have gall'	ạẓ̂:ạ:	'neighbour'		

The pharyngealization of the forms in (72) is caused by an underlying pharyngeal /ṛ/ which is deleted by the R-deletion rule (15), after pharyngealization spread had taken place. Except for the form ẑ:ð (~~have~~ gall), the instances given above contain an underlying ṛ.

As mentioned above, these four pharyngealized palato-alveolars are surface realizations of the ŝ, ŝŝ, ẑ, ẑẑ in pharyngealizing contexts.

f) Palatals:

The occurrence of the two palatals ç and y is illustrated by the data in (73):

(73)	Initial Position		Medial Position		Final Position	
ç:	çsi	'lift'	açsum	'meat'	————	
	çmz	'scratch'	amçan	'place'	————	
y:	yma:	'hunt'	iyma	'he grew up'	in:ay	'he mounts'
	yru	'gather'	imyran	'sythes'	ahnay	'big pole'

ç alternates with its voiced correspondent y as shown in (74) below:

(74)	Singular Form	Plural Form	Gloss
	θahnçt	θihnyin	'Pole: poles'
	θaqrçt	θiqryin	'tripe: tripes'

The two palatal fricatives above are recognized as independent phonemes of ATT. Yet, because of their limited occurrences, especially ç, in the variety being studied, they will not be considered in the phonotactic analysis undertaken in Chapters IV and V.

g) Velars:

The class of velars in ATT is made up of two voiceless stops (k and kk) and their corresponding voiced segments (g and gg); the voiceless fricatives (x and xx) and their voiced counterparts (i.e. ɣ and ɣɣ) the labialized kk^w and gg^w.

(i) The case of k, kk, g, gg:

These four segments are attested in almost all environments in ATT, as illustrated by the data in (75):

(75)	Initial Position		Medial Position		Final Position	
k:	kaBa:	'make do'	f̂kaŋki	'torch'	iht:k	'he's exhausted'
	km:f̂	'finish'	akaBasu	'bag'	————	
k::	k:a:	'get up'	ik:a	'he went by'	ifk:	'he untied'
	k:θ	'go by. pl'	ik:um:ŝ	'he knelt down'	sk:	'send'
g:	gaBa	'to court'	igmŝan	'cheeks'	————	
	gʒ:ɣ	'stand up'	f̂gns	'race'	————	
g::	g:it	'do it'	ng:a	'we did'	ang:	'we'll do'
	g:a:	'bake. Int'	θig:st	'tatoo'	atg:	'she'll do'

The velar geminate g: is very rarely attested in ATT (and other Berber varieties, cf. Chtatou (1982)); this is why most of the illustrative examples in (75) are related to the verb 'do' /gg/ (except for g:a: 'to bake' and θig:st: 'tatoo'). The four velar segments dealt with above are all members of the ATT phonemic inventory.

(ii) <u>The case of gg^w and kk^w:</u>

The two labialized geminates, <u>kk^w</u> and <u>gg^w</u>, contrast with their corresponding non-labialized velars, i.e. <u>kk</u> and <u>gg</u> :

(76)

	Initial Position		Medial Position		Final Position	
<u>k:</u>	k:θ	'go by'	snk:ariθ	'wake him up'		
<u>$k:^w$</u>:	——		$k:^w$ariθ	'insult him'		
<u>g:</u>:	g:θ	'do pl.'	ig:a	'he did'	ang:	'we'll do'
<u>$g:^w$</u>:	$g:^w$θ	'knead'	$ig:^w$a	'he kneaded'	$ang:^w$	'we'll knead'

These labialized velars have been treated differently in the literature on the phonology of Berber (Tarifiyt and Kabyle Berber). Chaker (1977:181), as reported in Chtatou (1982:146), posits an underlying sequence /ggw/ to account for the surface labialized velar <u>gg^w</u>. He writes:

> Dans ce parler Kabyle Berbère on ne rencontre jamais la succéssion Vèlaire ou Uvulaire Tendue + Semi-voyelle vélaire (/C + W/). C^w ne peut donc pas s'opposer à /C + W/. C^w doit être considérée comme une réalisation obligatoire de la suite /C + W/, lorsque /C/ est une consonne homorganique de /W/ (vélaire ou uvulaire): /C + W/ $\longrightarrow$ C^w.

Having adopted an analysis which does not recognize underlying glides, Chtatou (Ibid:148) argues that Chaker's analysis "cannot account for such a form as <u>gg^w</u> 'to knead bread', since underlyingly there is no following vowel /ggu/, which would motivate desyllabification", and concludes that such an analysis (i.e. Chaker's analysis) has to be rejected . Based on the argument above, Chtatou (Ibid) recognizes the underlying phonemes: $\underline{kk}^w$ and $\underline{gg}^w$.

Since underlying glides are recognized in the present analysis, (cf. I.2), we can assume,following Chaker (1977:181) that $\underline{g:}^w$ is the surface realization of /ggw/, a sequence not attested in surface forms in ATT except across morpheme boundaries:

(77)	Underlying Form	Surface Form	Gloss
	gg#win	g:win	'do that one'

Chaker's proposal can be made to apply for $\underline{kk}^w$ as well, that is, it is the surface realization of the underlying sequence /kk^w/. Yet, once again, such a sequence is not attested in surface forms in ATT except across morpheme boundaries:

(78)	Underlying Form	Surface Form	Gloss
	s#kk#win	sk:win	'send that one'

By positing an underlying geminate velar + W to account for the surface $\underline{kk}^w$ and $\underline{gg}^w$, it becomes necessary to posit a morpheme structure condition (cf.81) which would specify that within a morpheme, the sequences <u>kkw</u> and <u>ggw</u> are realized as $\underline{k:}^w$ and $\underline{g:}^w$, respectively:

(78) Morpheme Structure Condition:

$$\text{IF} \quad \begin{bmatrix} +\text{back} \\ -\text{cont} \\ +\text{tense} \end{bmatrix} +W \longrightarrow \text{Then} \quad \begin{bmatrix} +\text{labialized} \end{bmatrix}$$

The inclusion of the morpheme structure condition (79) in the grammar of ATT makes it unnecessary to posit $\underline{kk}^w$ and $\underline{gg}^w$ as underlying phonemes. The importance of such a solution lies in its capturing of a phonotactic generalization (within a morpheme) or a morpheme structure condition, which would be missed out by an analysis that posits underlying $\underline{kk}^w$ and $\underline{gg}^w$.

(iii) The case of x, xx, ɣ, ɣɣ:

With the exception of a few forms, the geminate ɣ: is not attested in ATT (cf. Chtatou, (1982) for IT Tarifiyt and Saib, (1974), (1976a) for Ait Ndhir Tamazight):

(80)	Form	Gloss
	iɣ:aBr̂	'he cleaned'
	iɣ:umba	'he frowned'

The voiceless correspondent of ɣ: is also rarely attested in ATT, as the data in (81) show:

(81)

Surface Forms	Gloss
ax:am	'room'
r̂mux:	'brain'
ix:axa:	'he's unhealthy'

Unlike ɣ:, the velar fricative x: contrasts with its [-tense] correspondent:

(82)

	Surface Forms	Gloss
x:	axam	'on you . Fem.'
	rux	'now'
x::	ax:am	'room'
	r̂mux:	'brain'

The segments x and ɣ are attested in all environments in ATT:

(83)

	Initial Position		Medial Position		Final Position	
x:	xar̂i	'my uncle'	ixs	'he wanted'	nix	'or'
	xǒm	'work'	θaxŝft	'trap'	swix	'I drank'
ɣ:	ɣas	'he has'	aɣraw	'sleeve'	azgg^{w}aɣ	'red'
	ɣaδa	'only here'	aɣi	'butter milk'	zδɣ	'inhabit'

Based on the discussion above, the velar fricatives which are recognized as independent phonemes in ATT are: x, xx, and ɣ .

The pharyngealized counterparts of these three velars are attested on the surface in pharyngealizing contexts:

(84)	Underlying Forms	Surface Forms	Gloss
	i+xxaṛwð̌	ịx̣:ạ:ẉð̣̌	'he mixed'
	f̂xaṛθif̂	f̣̂x̣ạ:θ̣ịf̣̂	'dirty person'
	ɣaṛð̌a	ɣ̣ạ:ð̣̌ạ	'mouse'

The surface forms in (84) above are the result of the application of the pharyngealization process (c.f.fn.4) and the R-deletion rule (15).

h) Uvulars

The uvular q and q: are attested in all environments in ATT. Their distribution is illustrated by the data in (85):

(85)	Initial Position		Medial Position		Final Position	
q:	qim	'sit down'	aqnin:i	'rabbit'	f̂Bruq	'lightning'
	qawit	'peanuts'	aqzin	'dog'	iBa:q	'he saw'
q: :	q:a:	'study Int'	θq:im	'she sat down'	f̂Bq:	'a bug'
	q:n	'to tie'	aŝq:if	'injury'	θaq:	'it's burning'

There are instances which testify to the alternation ɣ/q: , as the data in (86) show:

(86)

Unmarked Form	Intensive Form	Gloss
ɣ̣ạ:	q̣:ạ:	'study'
ạ:ɣ̣	ạ:q̣:	'burn'
nɣ	nq:	'kill'

Such alternations suggest that it is possible to posit an underlying q to account for the surface ɣ . Yet, as Chtatou (I982:I5I-152) rightly argues, it will be unnatural to say that the [+back, +cont, -high] in the forms in(87) is underlyingly q :

(87)

Surface Forms	Gloss
aɣrum	'bread'
aɣi	'milk'
aɣr̂ar̂	'snail'
aɣjur̂	'donkey'

Moreover, under an analysis which assumes that ɣ is the spirantized counterpart of the underlying q, it will be difficult to account for the non-spirantized occurrences of q in the forms in (88):.

(88)

Surface Forms	Gloss
qðu	'cut'
qr̂B	'reverse'
θqBr̂	'she accepted'

In conclusion, the uvular segments recognized as phonemes in ATT are q and qq.

i) Pharyngeals and laryngeals:

The data in (89) illustrate the various occurences of pharyngeal segments ħ, ʒ, ħ:, ʒ: and the laryngeal segments h, h::

(89)

	Initial Position		Medial Position		Final Position	
ħ:	ħaða	'touch'	θaħnçt	'pole'	f̂mf̂ħ	'salt'
	ħf̂i	'hit with a stick'	f̂ħmf̂	'load'	raħ	'go'
ħ::	ħujzx	'I miss'	tħaa	'destroy'	——	
ʒ:	ʒað	'not yet'	aʒf̂aw	'rug'	qf̂ʒ	'uproot'
	ʒa:n	'push'	θʒða	'she went by'	za:ʒ	'sow'
ʒ::	——		Bʒ:ð	'go away'	——	
h:	hwa	'go down'	ihða	'it ate grass'	ndh	'drive'
	ha:wð	'step over'	θhna	'she's at peace'		
h::	h:awðn	'they stepped over'	inh:a	'to warn Int.'	——	

The laryngeal and pharyngeal geminate continuants are not attested in final position in ATT. There are no instances illustrating the oppositions: (ħ, ħ:), (ʒ, ʒ:) and (h, h:). The single laryngeal h seems to contrast with its geminate counterpart:

(90)	Unmarked Form	Intensive Form	Gloss
	nha	nh:a	'warn against'
	fhm	fh:m	'understand'

The gemination of h is morphologically governed (cf. Saib (1974), (1976a)), and, as such, the geminate h: cannot be considered a phoneme of ATT. The other pharyngeal geminates are rarely attested in ATT.

The set of laryngeal and pharyngeal segments considered as phonemes of ATT is the following: ḥ , ʒ , .

I.6 Conclusion

Based on the discussion above, it can be concluded that the optimal phonological system of ATT is made up of the following phonemes:

(91) a. Vowels: a, i, u

b. Glides: j, jj, w, ww,

c. Liquids: l, ll, r, rr, ṛ, ṛṛ, r̂, ḷ, ḷḷ

d. Nasals: m, n, mm, nn, $ŋŋ^{w}$

e. Obstruents:

(i) Labials: b, bb, f, ff

(ii) Dentals: t, tt, θ, d, dd, ð, ṭ, ṭṭ, ḍ, ḍḍ, ð̣

(iii) Alveolars: s, ss, z, zz, ẓ, ẓẓ

(iv) Pre-palatals: ĉ ĵ

(v)Palato-alveolars: ŝ, ẑ, ŝŝ, ẑẑ,

(vi) Palatals: ç, y

(vii) Velars: k, kk, g, gg, x, xx, ɣ

(viii) Uvulars: q; qq

(ix) Pharyngeals: ħ, ʒ

(x) Laryngeals: h

Footnotes to Chapter I

(1) Biarnay (1917) deals with the following tribes of the Rif: Aiθ-Ittefθ, Ibeqqoien, Aiθ-Uriayen, Aiθ-θemsaman, Aiθ-sʒio, Iqrʒiyyen, Içbdanen, Aiθ-θuzine (referred to as Asht-Touzine in the present work), and Bettioua (see map, p.4).

(2) The main difference between the list of phonemes proposed by Biarnay (1917) and that proposed by Renisio (1917) is that the latter includes the vibrant ř((r̂ in our notation); other differences are irrelevant for the present analysis.

(3) Chtatou's (1982) long vowels e, ɑ , o, ạ, and ọ are represented here as e:, a:, o:, ạ:, and ọ: respectively. and his š and ž are represented as ŝ and ẑ.

(4) Chtatou (1982: 260-26) notes that pharyngealization spread in IT can be accounted for by the following rule:

Emphasis Spread in Iharassen Tarifit

$$\left\langle \text{syllable}, \quad \begin{array}{ccc} & [+\text{seg}] & \\ \ldots & [+\text{seg}] & \ldots \\ & [+\text{RTR}] & \end{array} \right\rangle$$

He explains that this rule accounts for pahryngealizati tion spread within the syllable, and adds the following rule to account for its spread beyond the syllable:

Pharyngealization Expansion

$$\begin{bmatrix}\sigma \\ \ldots\end{bmatrix} \longrightarrow [+\text{RTR}] \;/\; \underline{\qquad}\begin{bmatrix}\sigma \\ \ldots\end{bmatrix}\underline{\qquad}$$

Throughout the discussion below, we assume that these two rules are also operative in ATT.

(5) It is assumed here that the sequence X X is not separated by any boundary (cf. El Medlaoui (1988b) for a detailed account of long segments).

(6) Regarding the over-loading of phonological rules with morphological and/or synatactic information, Bader (1988) cites M.Kenstowicz and C.Kisseberth (1979) who state that "all other things being equal, a phonological solution is preferred over a solution [...] that lists the morphological/syntactic context in which a rule applies."

CHAPTER TWO

THE STUDY OF PHONOTACTICS IN NATURAL LANGUAGES: A REVIEW OF THE LITERATURE

II.0 Introduction

This chapter is concerned with a survey of some works that have dealt with the syllable and its relation to phonotactic constraints in natural languages, Berber included. The main works dealt with are: Vennemann (1972, 1974), Hooper (1976), Selkirk (1982, 1984) Halle and Clements (1983), Saib (1978), Chtatou (1982) and Boukous (1987). Section one is an attempt at highlighting the importance of the syllable as the appropriate domain for stating phonotactic constraints. Section two investigates the internal constituents of the syllable and presents some arguments put forward by some phonologists (e.g. Selkirk 1982) in support of the superiority of a hierarchical syllable representation over a linear one. Works written within both frameworks (i.e. the linear and the non-linear syllable representations), and which have dealt with the phonotactics of Berber, are presented in section three.

II.1 The syllable in phonotactic studies

The necessity of expressing generalizations about segment organization within the domain of the syllable has been repeatedly emphasized in various works. Vennemann (1974:350) states that the phonotactics of languages, or "the phonological rules that specify what is and what is not pronounceable in language," is best formulated in terms of "possible and impossible syllables of the language." He writes:

> Since syllables are the minimal pronounceable units in each language, the phonological rules specify in particular the possible and the impossible syllables of the language (Ibid.,p350).

In an earlier work (Vennemann I972), the author proposes a "consonantal strength" scale "to capture the relation between segment type and syllabification" (cf. Hooper I976:179). The consonantal strength he gives for Modern Icelandic is reproduced in (1):

(1)

j u	r	l	m n	f b d g	s	p k	t
1	2	3	4	5	6	7	8

Such a strength scale allows for a straightforward formulation of a syllable insertion rule, referring to consonants by their indices of strength rather than by distinctive features:

(2) $\emptyset \longrightarrow \$ \; / \; V \_\_\_\_ \; [\text{m-strength}] \; [\text{n-strength}] \; V$

condition $m \geq 6$, $n \leq 2$.

Commenting on the relevance of strength indexing, Hooper (Ibid) notes that since it is "correlated with the strength of syllable position, it can explain phonotactic constraints on segments."

The essence of the above claims about the necessity of stating phonotactic constraints in terms of conditions on possible and impossible syllables is embodied in Hooper (Ibid).

There, the author argues that the morpheme is not the proper domain for stating constraints on segment organization. Her reason is as follows:

> Because MSCs (Morpheme Structure Conditions) are stated in terms of morphemes, for most languages they cannot capture all the generalizations about sequence structure. This is because the morpheme is by definition a syntactic unit.
> (Hooper 1976:187)

To illustrate the inadequacy of MSCs in the statement of phonotactic constraints, Hooper (Ibid) offers the following examples from Spanish:

(3)	Forms	Gloss
	abl+ar	"to speak"
	Kompr+ar	"to buy"
	Kans+ar	"to be calm"

She comments that none of the final clusters in the above forms, namely bl, pr, ns, is acceptable word or utterance-finally, and adds that "MSCs would have to state that such phonological sequences are acceptable." Thus, she joins Vennemann (1974) in stating that the syllable "being the smallest pronounceable unit," it is the appropriate domain for stating constraints on sequence structure.

An example that Hooper ( ) gives to illustrate that a word is a sequence of well-formed syllables is the hypothetical English word stabnick. This word has an acceptable sound structure and can be divided into two acceptable syllables in English: stab $ nick. The hypothetical form *stambnick is not acceptable because the segment b cannot be syllabified with either the first or the second syllable (: *stamb (in stamb$nick), *bnick (in stam $ bnick)).

More recently, Selkirk (1982) deals in detail with the structure of the syllable and its function as the domain for stating phonotactic constraints. She states that "it can be argued that the most general and explanatory statement of phonotactic constraints in a language can be made only by reference to the syllable structure of an utterance." (Selkirk Ibid:337). She advances strong evidence in support of the relation of phonotactic constraints to the constituents of the syllable. These are the onset and the rime as the immediate constituents of the syllable, and the nucleus and coda as immediate constituents of the rime. This issue concerning syllable constituency and phonotactic constraints will be taken up in more detail in section (II.3).

Another recent work which demonstrates that the syllable is the proper domain for expressing phonotactic constraints is Halle and Clements (1983). These authors also testify to the efficiency of the syllable as a domain for phonotactic constraints. They join other phonologists who "have noted that the domain over which a great many such constraints [on what phonemes can combine into sequences] hold is the syllable" (Halle and Clements (Ibid:15)). They illustrate their claim by an example from English, where "word initial consonant clusters consisting of three members must have the form: [s] + [p, t, k] + [l, r, w, y]." (e.g; spring, string, scrimp, splint, squint, skew).

The constraint on the segment sequences above, Halle and Clements state, "is in fact a constraint over syllables rather than over words." They explain that words like <u>construct</u> and <u>astronomy</u> are well-formed because they "can be broken up into sequences of well-formed syllables (con-struct, a-stro-no-my)." On the other hand, "pseudo words like <u>consknuct</u> and <u>apftonomy</u> cannot, [because they are ill-formed forms]." (Clements and Halle(Ibid.,pp.16)

II.2 <u>The syllable and the word in phonotactic studies</u>

Despite the apparent conscensus reached about the syllable being the appropriate domain for stating phonotactic constraints some phonologists have expressed a doubt about the efficiency of the syllable <u>alone</u> in stating generalizations about sequences Vennemann (1974:356) for example, insists on the necessity of referring to the <u>word</u> as well as the syllable in an analysis of segment sequences:

> Since I am quite convinced by our arguments for the relevance of the syllable as a domain of phonological constraints, in a goodly number of cases my assumption merely means that the proper domain is the syllable <u>in its relation to the word</u>, i.e. the syllable together with information about its position in the word.

He explains by referring to Japanese where voiceless stops are allowed "as parts of geminates in syllable-final position except in the last syllable of a word." It is obvious therefore, according to Vennemann (1974), that reference should be made to the position of the syllable within the word.

A similar conclusion is reached by Basbøl (1974) in his analysis of the consonantal structure of the word in Italian. He also recognizes the syllable and the word as the domains for stating phonotactic constraints. The condition that Basbøl (1974) advances for the syllable to be a sufficient domain in accounting for the distribution of the consonants in Italian is that consonant sets in the middle of an utterance are expected utterance-initially and utterance-finally.[1] In Italian, for instance, reference cannot be made to the syllable in isolation from its position in the word; the segment /s/ is syllable final only inside the word, and clusters of /s/ + another consonant are allowed syllable-initially only word-initially.

Basbøl (Ibid:28) explains that whether it is the syllable or the word which is the appropriate domain for stating generalizations on consonant sequences is an empirical question. That is, if the condition above (about consonant sets) is met, and the syllable boundaries are consistent with other facts of the language, then the syllable can be the domain of phonotactic constraints.

The issue of referring to the word and the syllable has not been so far raised in studies on the phonotactics of Berber, except in Saib (1978), (1981). As will become clear in the present analysis, the syllable with reference to the word is considered as the proper domain for capturing generalizations on segment structure (cf. General Conclusion)

In ATT, not every syllable ~~type is attested~~ in all environments. It will be seen (cf. Chap. III) that syllables of the type CCV(C) are found only utterance-initially, and that syllables of the type (C)CVCC are found exclusively utterance-finally. This observation concerning the occurence of syllable types automatically implies that there are different constraints on segment sequences, depending on the syllable they occur in: in the middle of the syllabification domain, there can be no cluster of the type mθ in the R_2 R_3 position, since these positions are filled only utterance-finally (cf. Chap. III, Sect. V.3, and Chap V. Sect. 3)[2]

The observations above about syllable position and phonotactic constraints are true only if the syllabification domain does not exceed the maximal string of segments where no pause can be inserted, even in careful speech. In other analyses of syllable structure in Berber where the domain of syllabification is larger than the minimal utterance (cf. El Medlaoui (1985), Boukous (1987)), these observations do not hold. Thus, if the cluster R_2 R_3 does not occur inside the minimal utterance, it can however, in a larger utterance where a pause can be inserted between constituents of that utterance.

To illustrate, consider the examples below:

(4) a.	r̂qa<u>nt</u>	'they met'	b.	r̂qa<u>nt</u> fatima	'they met Fatima'
	usi<u>nd</u>	'they came'		usi<u>nd</u> ɣari	'they came to me'

The underlined clusters in (4a) occur at the end of the utterance whereas those in (4b) occur in the middle of the utterance, which is here a complete sentence.

II.3 The structure of the syllable in general

II.3.0 Introduction

The conception of the syllable by various phonologists is not as uniform as the preceding section might have suggested. There are various syllable representations reflecting different approaches to phonological representation. The task of the present section is to attempt to provide a survey of two main syllable theories which have dealt with phonotactic constraints in different languages. These are the linear representations in Vennemann (1972, 1974) and Hooper (1973, 1976), and the hierarchical representation in Selkirk (1982, 1984). These two different modes of syllable representation will be considered in the light of their efficiency in capturing generalizations about the phonotactic constraints of natural languages in general and of Berber in particular.

II.3.1 Linear representation

Vennemann (1972), (1974) conceives of the syllable as a string of segments delimited by syllable boundaries. Such a linear representation is exemplified by rule (2) in section II.1 and reproduced here for ease of reference:

$$(5)\quad \emptyset \longrightarrow \$ \;/\; V \;\_\_\_\_\_\; [m\text{-strength}]\;[n\text{-strength}]\; V$$

$$\text{condition} \quad m \geq 6,\; n \leq 2$$

The numbers assigned to the indices m and n, respectively refer to the strength scale for Modern Icelandic proposed by the same author in (1)) and repeated in (6) below:

(6)

1	2	3	4	5	6	7	8
				f			
				b			
j			m	d		p	
u	r	l	n	g	s	k	t

As stated earlier, the advantage of the strength scale in (6) and the rule in (5) is that the phonology of Modern Icelandic will not have to refer to the features of individual segments, or the segments themselves, that are the input to the syllabification rule in (5). Thus, as Hooper (1976:197) comments, "Vennemann's proposal captures the relationship between the universal intrinsic structure of the syllable and the distribution of segment types in the syllable." That is, "weak" positions are occupied by weak consonants and "strong" positions by strong consonants (cf. the strength scale for Modern Icelandic for example).

Hooper (1976) further develops Vennemann's (1972) proposal, but still adopts a linear representation of the syllable. She proposes the strength hierarchy for American Spanish in (7), together with the syllable structure conditions in (8):

(7)

						f		
					B	b	p	
y			m	s		d	t	
w	r	l	n	x		g	k	c
1	2	3	4	5	6	7	8	→

(8) $P(c)\colon \$\ C_m\ C_n\ C_p\ V\ C_q\ C_r\ \$$

If $n > 1$, then $m \geqslant 6$

$m > n$

$p,\ q = 1$

$r \leqslant 5$

$n > p$

$r > q$

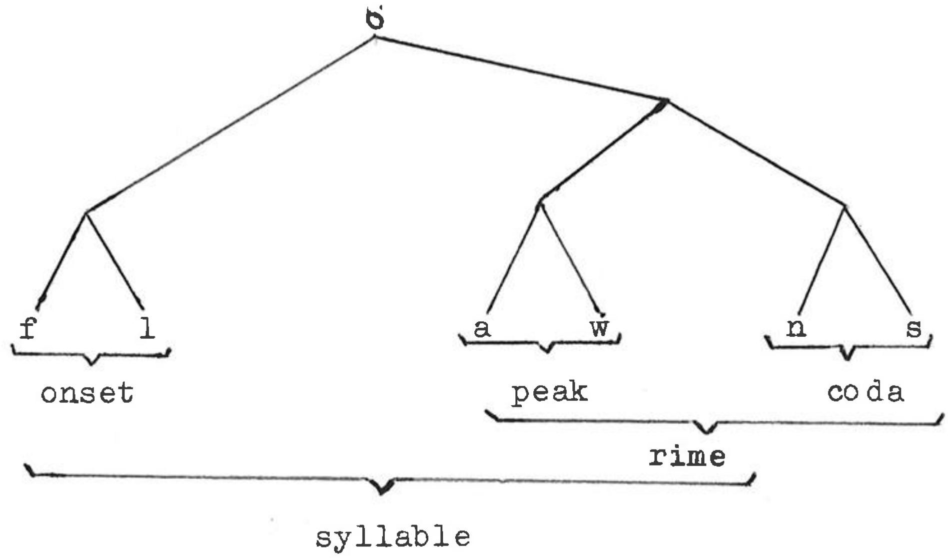
The sub-indices (m, n, etc) in (8) above indicate the position that a segment may fill within the syllable. For example, C_m is the position for a syllable-initial consonant, and C_r is the position for a syllable-final consonant.

From the above succint presentation of the two linear representations, it becomes clear that statements about the sequence structure of the segments refer to the syllable as a string of elements. The shortcomings of such linear conceptions of the syllable are brought to light by the presentation of Selkirk's((1982), (1984)) hierarchical syllable representation, to which we shall turn next.

II.3.2 Hierarchical representation

Selkirk (1982:337-8) argues that there is strong evidence for the hypothesis that "the syllable is an element of a hierarchically organized prosodic structure." How a word like flawns will be assigned a syllable representation is an illustration of the hypothesis that she defends (Selkirk (Ibid.:338):

(9)



As can be seen in (9) above, the immediate internal constituents of the syllable are onset and rime. The rime is made up of the peak and the coda. Such an internal constituency is highly motivated by phonotactic considerations. To explain this, we quote Pike (1967:386-7) cited in Selkirk (Ibid.:338-9):

> The possibility of substituting one phoneme for another in a partiaular slot in the margin, for example, is likely to be more dependent upon the particular phonemes manifesting other slots in that margin than it is by the particular phonemes manifesting the nucleus of such syllables.

Pike (Ibid) explains that in a CCV sequence in English, when the first C is filled with /s/ and the V with the vowel /a/; for example, the second C slot is conditioned by the existence of the /s/ in the first C position rather than by the /a/ in the V-position:

> The list of phonemes which fill the second consonant slot are more likely to be controlled by the presence of the /s/ than they are by the presence of the /a/.

The elements constituting the margin in Pike's terms (Ibid) hold a close relationship among themselves and so do the ones constituting the coda.

Selkirk (Ibid) also cites Kurylowicz (I948) who advocates that peak and coda are a constituent of syllable composition (rather than onset and peak, for example). She observes that "the more closely related structurally [...] the more subject to phonotactic constraints two position slots are." (Selkirk (Ibid:339)).

To illustrate the above claims about syllable constituency we reconsider the syllable representation in (9) above. The inadmissibility of the consonant d, for instance, in the second C slot (instead of the l which fills the position in (9)) is conditioned by the f in the first position, rather than by the presence of <u>a</u> in the nucleus (or rime) position. This is so because English does not admit <u>fd</u> clusters syllable-initially, i.e. in the onset position.

This hierarchical syllable representation is superior to the linear one advocated by Vennemann (1972), (1974) and Hooper (1976), "for it allows for quite a restrictive characterization of the notion 'possible phonotactic constraint of language L'"(Selkirk (Ibid:339)). The linear representation according to Selkirk, would give no significance to "the fact that strong phonotactic constraints existed between positions 1 and 2, 3 and 4, 5 and 6, [in (10) below] but not between other pairs":

(10) \$ f_1 l_2 a_3 w_4 n_5 s_6 \$

Selkirk (Ibid:340) comments that a possible formulation of the phonotactic constraints in the linear approach would be:

> Syllable-initial consonant clusters, the sonorant elements of syllable centers, and syllable final consonant clusters tend to exhibit phonotactic constraints among themselves.

It becomes clear, then, that a hierarchical representation of the syllable allows for a straightforward formulation of these constraints by referring to the syllable constituents where stronger relations (or phonotactic constraints) hold.

Such a formulation is made more explicit in a recent work by the same author (Selkirk (1984)). The importance of this work lies inthe detailed proposal that it provides to capture generalizations about the syllable structure and phonotactic constraints in natural languages, using the sonority indexing scheme and the [n-sonority] feature. This is discussed next.

II.3.2.1 The sonority feature

The importance of the sonority feature in phonotactic studies and its superiority over an analysis adopting the major class features ([± syllabic], [± consonantal] , [± sonorant]) are highlighted in Selkirk (1984). In this work, Selkirk argues that "all the major class features [...] should be eliminated from phonological theory," and most particularly "in a truly explanatory theory of syllable phonotactics they must be given no role." These major class features, according to this author, "must be replaced in effect by the sonority hierarchy and the assignment of a sonority index to individual segments that reflects the niche they occupy in that hierarchy." (Selkirk(Ibid:110)).

The role of the sonority feature lies in capturing generalizations about segment organization in the syllable. This organization is explicitly formulated by the following universal generalization (Selkirk(Ibid:116)):

(11) <u>Sonority Sequencing Generalization</u>

> In any syllable, there is a segment constituting a sonority peak that is preceded and/or followed by a sequence of segments with progressively decreasing sonority values.

The elimination of major class features and the introduction of the [n-sonority] feature allow for a simple expression of natural classes that play a role characterizing a syllable structure in natural languages. Thus, "the class 'glides plus consonants' is simply the set of segments whose sonority indices range from 8 (i̲, u̲) to 5 (nasals)." Similarly, "the class 'glides plus consonants' includes segments whose indices are less than or equal to 8." (Selkirk (Ibid:II2)).

Before proceeding to the examination of the sonority indices and their relation to the syllable structure, a word about the motivation of the 'relational' values assigned to segments in terms of sonority indices is in place. A hierarchical sonority scale like the one in (11) has at least two main sources of motivation: first, it is a means of capturing generalizations on the segment combination in a given language. For example, the segment that constitutes the syllable peak has a sonority index superior to that of the segments occuring in the same syllable. The segment occuring in the first constituent of the onset has a sonority index inferior to that of the segment following it, etc. These generalizations are captured by the Sonority Sequencing

Generalization in (11).

Second, it has been argued by various phonologists that some phonological rules are better stated in terms of sonority indices than in terms of binary distinctive features. For example, Hankamer and Aissen (1974), in their analysis of an assimilation rule in Pali ('a classic language in India') demonstrate that "it is only in terms of such a hierarchical relation among classes" that this assimilation rule can be formulated.[3] The bulk of their argumentation is that (a) more sonorous segments assimilate in all features to less sonorous segments, and (b) "if the consonants are of equal rank on the hierarchy, the assimilation is regressive (the first assimilates to the second." (Hankamer and Aissen (Ibid:132)).

In the examples they provide, and which are reproduced below, s assimilates to t in the first form, and to k in the second form:

(12)	vas	+	tum	⟶	vatthum	inf.vas	'to dwell'
	vak	+	ssa	⟶	vakkha-	fut.vak	'to speak'

Another assimilation process they cite is taken from Hungarian (Hankamer and Aissen,(Ibid:138)). In this language l assimilates to r and y, and y assimilates to nasals, fricatives and stops. In other words, more sonorous segments assimilate to less sonorous ones.

With respect to the exact value of a given segment, or the precise niche it may occupy in the sonority scale, the authors state;

> As a result of [...] variability, we expect that every language has its own sonority hierarchy or rather that the scale is universal but every language places its segment types along the hierarchy at points determined by the language particular features of articulation; for such classes as stops, fricatives and nasals, there is little variation from language to language, and no inversions of order i.e. nasals are more sonorous than fricatives, fricatives are more sonorous than stops.

The exact value to assign to a segment, as Selkirk (1984:112) convincingly argues, is not as important as the relation of that segment to other segments in the same sonority scale. Thus, whether b and d have 1 as their sonority index or 1.5 is not as important as their relation to voiceless fricatives; these [+voice] segments should be placed below and not above the [-voice] fricatives in view of their behaviour in the language for which a sonority scale is set.

Having provided an explanation of, and motivation for, the sonority indexing scheme, an illustration of the n-sonority feature assigned to the segments of a language and how it conditions the syllable terminal positions becomes necessary. This is the object of the discussion in the section below. In addition, we consider the syllable structure which serves as the domain where conditions cast in terms of sonority indices apply.

II.3.2.2 Sonority indexing and the syllable structure

Selkirk (1984:114) conceives of the syllable as a set of subcomponents. She writes:

> Given an autosegmental theory of the syllable, the phonotactic description of the syllable has at least three parts: (i) the characterization of possible syllable structures, (ii) the characterization of possible (and impossible) sequences on the melody tier, and (iii) the characterization of possible associations between the two.

The elements necessary for the description of each of the above 'parts' are also given by the author (Selkirk, (Ibid:114). Thus, concerning the first part (i.e. the characterization of possible syllable structures), she states:

> Included in the conditions of type (i) which define the possible syllable trees for a language, are (a) a characterization of the internal structure of a syllable (perhaps only a (universal)) division into onset and rime, (b) a specification of the minimum and maximum number of terminal positions in the syllable, and (c) a set of conditions on the terminal nodes.

The internal constituents of the syllable in ATT, together with the minimum and maximum number of syllable terminal positions are mirrored by the template of ATT (cf.III.1)and conditions on the terminal syllable positions are also given in Chap. III where it will become clear that the syllable constituents are a branching onset (i.e. onset with two positions) and a complex rime (with three positions). The conditions accompanying the template define the class of segments which can fill a given position.

With respect to the theoretical constructs required for the characterization of possible (or impossible) sequences on the melody tier (i.e. part (ii)), Selkirk (Ibid:II4) explains that it is essential to include "specific filters (collocational restrictions, in the sense of Fudge (I969) and Selkirk (I982)) that rule out particular sequences of segments.

Such filters would exclude combinations wrongly predicted by the sonority conditions of a given language. Thus, in ATT for example, although the combination tB is admissible in the onset, the combination kB is not. Since t and k have the same SI, (cf. Chap. III), any condition in terms of sonority indices will refer to both segments, whereas there is need to say that t is allowed before B, but k is not. (cf. the detailed discussion of filters in Berber in Chap. II, Sect. 4).

Concerning the characterization of possible associations between the syllable structure tier and the melody tier, Selkirk writes:

> Included in (iii) is the universal condition that association lines do not "cross", as well as the universal condition that a segment α may by associated with a terminal position β in syllable structure only if α is non-distinct (in a manner to be made precise) from β .

The above parenthetical note about the manner of association refers to "the sonority index" of a segment X that may fill a position Y in syllable structure. X must have the same sonority index (or fall within the range of sonority indices) specified by conditions on a syllable terminal position Y. An example of the formulation of these conditions is given below:

(13) If X is associated with O_1, then SI (X) $\leqslant$ 8

That is, for a segment X to fill one position in the onset, the sonority index of that segment X (SI (X)) must be inferior or equal to 8. Such conditions, of course, will be meaningless unless there is a point of reference for the indices in question. This point of reference is the sonority hierarchy in (14):

(14)

Sound	Sonority Index
a	IO
e, o	9
i, u	8
r	7
l	6
m, n	5
s	4
v, z, o	3
f, θ	2
b, d, g	I
p, t, k	.5

After this brief demonstration of the superiority of the hierarchical syllable representation over the linear one, and of the efficiency of the use of the sonority features in capturing generalizations on segment organization, we turn to a survey of studies on the phonotactics of Berber.

II.4 The study of phonotactics in Berber

Having exposed some of the prominent characteristics of the non-linear model in phonological representation, we turn now to survey, briefly, some of the claims concerning Berber phonotactics. The works dealt with in this section are Saib (1978), Chtatou (1982) and Boukous (1987).

a) Saib (1978)

Apart from providing evidence for syllable-based analyses in Berber, Saib, (1978:101) notes that "not all the hypotheses made concerning segment organization within a syllable are borne out by the Berber data." He observes that some segment sequences in syllable-final position in Berber represent counter-evidence to claims put forward by Hooper (1976) regarding syllable structure conditions. These are the word final clusters of obstruent and nasal, obstruent and liquid and obstruent and glide. Some examples are given in (15):

(15)

Forms	Gloss	Forms	Gloss
ijr	'field'	ujl	'molar'
ifr	'wing'	usm	'lightening'
ajl	'to hang'	asy	'to be aware of'

The claim about syllable structure that is violated by the above examples is that segments in the margin of a syllable (or the coda in the examples in (15)) should be decreasing in sonority from the nucleus to the last element in the margin (or increasing in strength in Hooper's terms). For example, a sequence such as art is well-formed with respect to the condition on syllable structure, but a sequence like atr is ill-formed because r is more sonorous than t (or weaker than t with reference to strength hierarchies).

The reason behind this violation of the strength hierarchy Saib (Ibid:I02) explains, is that "(i) the clusters are created in casual speech, and (ii) the trend in this language [Berber] is not towards dropping the liquids and nasals so as to revert to the preferred syllable structure [...] one yielding syllables with a minimum coda," and finally, that (iii) these sequences are "partly due to a morphological process."

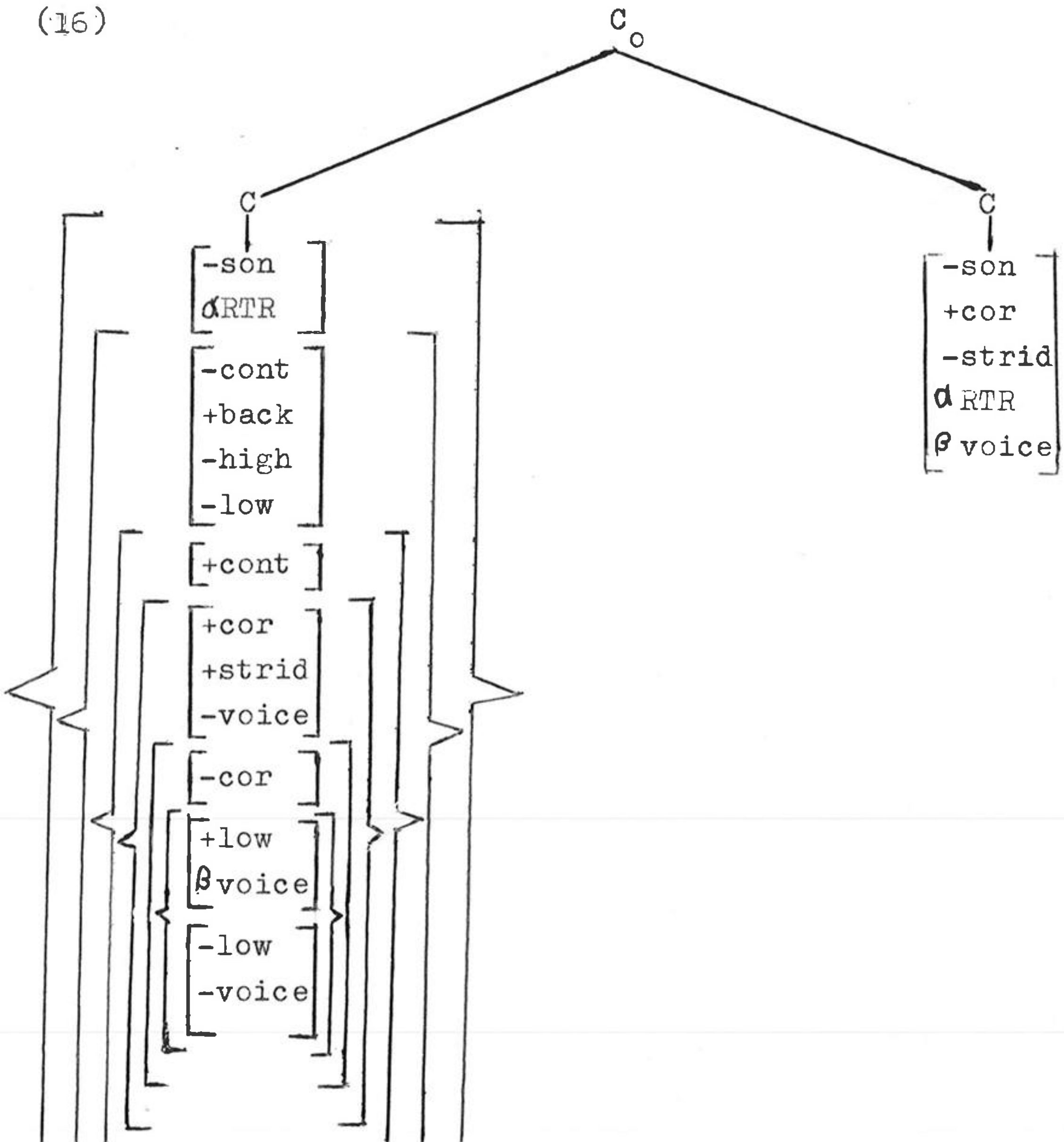
As will become clear in Chap. III of the present work, ATT displays sequences that violate the Sonority Sequencing Generalization. Syllabification and resyllabification rules, however, split these sequences in conformity with core syllabification and other rules to yield forms, in most cases, that do not violate this generalization.

A second observation made by the same author (cf. Hyman (I975)) is that "Berber allows CC\$ sequences but not \$CC sequences." That is, a syllable in Berber cannot start with two consonants in careful speech, but it can end with two consonants. This observation is confirmed in Chtatou (I982), whose claims about the syllable structure of Iharassen Tarifiyt are briefly reviewed below.

b) Chtatou (1982)

Chtatou (1982) provides a number of conditions on sequences of segments in the coda position in Iharassen Tarifiyt. He proposes three positive syllable structure conditions to account for coda clusters attested in the same variety. These conditions stated in terms of distinctive features make it difficult to see any relations holding between elements of the coda clusters (Chtatou (1982) allows onset clusters). We reproduce Chtatou's (1982:232) third syllable structure condition (SSC) to illustrate the complexity of the conditions in question:

(16)



The SSC in (16) generates the following clusters: xt, fθ, sθ, ṣθ, šθ, ç̌θ, xθ, ḥθ, qθ, ʒθ, ʒθ̣, ʒð, ʒð̣

It should be noted that ~~most~~ of the clusters involved in this condition do not conform to the Sonority Sequencing Generalization given in (11). In the cluster: qθ, the sonority index of the second element is higher than that of the first element. The segments involved in the codas: fθ, sθ, ṣθ, šθ, ç̌θ, xθ, ʒð, and ʒð̣ have the same sonority index, and the sonority index of the first segment is superior to that of the second one in the clusters ʒθ and ʒθ̣ which is in conformity with the sonority sequencing generalization.(11).

The role of the sonority hierarchy in accounting for segment organization in Berber is tested in Boukous (I987). In this work, Boukous shows the merits and limitations of the sonority indexing scheme. He argues for the inclusion of the feature PA (place of articulation) in phonotactic studies, together with filters, to rule out unattested clusters in the variety he studies (Tashelhiyt Berber, spoken in Agadir). These issues are dealt with in detail in the review of Boukous (Ibid) provided below.

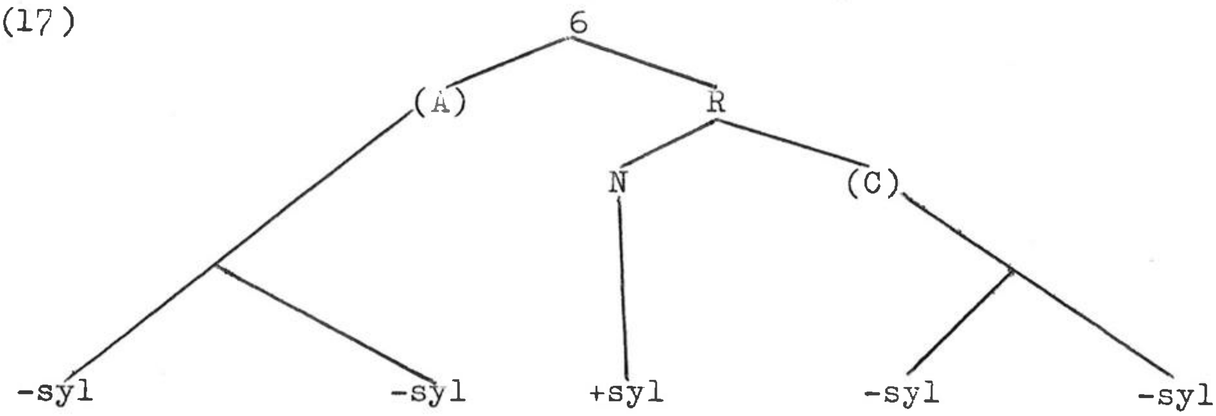
c) Boukous (I987)

Boukous (I987) studies the phonotactic constraints that govern segment organization in the Tashelhiyt variety spoken in Agadir (Parler d'Agadir). He opts for a hierarchical representation of the syllable, together with larger prosodic domains, namely the phonological word and the intonational phrase.

These two larger prosodic domains, Boukous (Ibid) argues, make any reference to boundaries or junctures to delimit the application of phonological rules and phonotactic constraints unnecessary, especially when dealing with sandhi phenomena.

Of interest to our present work is the syllable template that the author proposes for the variety he deals with (PA), and the set of conditions on terminal syllable positions. This syllable template allows for a branching onset (with two elements), one nucleus position, and a branching coda (with two elements) or complex rime as shown in (17) (Boukous, Ibid:158):

(17)



(A= Attaque (Onset); R= Rime (rime))

The feature [± syllabic] should not be taken as a specification of the inherent feature of a segment; the author considers all segments in (PA) to be eligible for syllabicity:

"En PA, toutes les consonnes peuvent être syllabiques" (Ibid:199).

The same syllable template will be proposed for ATT (the focal variety in this work), as will be seen in Chap. III. Yet, it will become clear in the chapter that such a template is workable in ATT only if geminate segments are allowed to fill a single syllable terminal position at the beginning of the syllabification domain, especially if this same template is meant for phonotactic syllables.

Regarding conditions on syllable terminal positions, these are formulated with reference to a 'sonority scale' and an 'articulatory scale' (échelle articulatoire) (cf. Section II.2.2 for the sonority scale (or hierarchy)). The articulatory scale allows for the assignment of a feature PA (Place of Articulation m) to the segments of the PA variety. For example, (Boukous, Ibid:347), the segments b, m, f have the same articulatory index (IO) but different sonority indices: 2, 5, 3 respectively. In Boukous' formalism, these are specified as in (18) below:

(18) $$\overset{b}{\begin{bmatrix} \begin{bmatrix} \text{son} \\ 2 \end{bmatrix} & & \begin{bmatrix} \text{PA} \\ \text{IO} \end{bmatrix} \end{bmatrix}} \; ; \; \overset{m}{\begin{bmatrix} \begin{bmatrix} \text{son} \\ 5 \end{bmatrix} & & \begin{bmatrix} \text{PA} \\ \text{IO} \end{bmatrix} \end{bmatrix}} \overset{f}{\begin{bmatrix} \begin{bmatrix} \text{son} \\ 3 \end{bmatrix} & & \begin{bmatrix} \text{PA} \\ \text{IO} \end{bmatrix} \end{bmatrix}}$$

The use of both indexing models brings about an efficient formalization of filters that will rule out inadmissible sequences of clusters. The illustration of this efficiency is given below, together with a discussion of the motivation of [PA-features] and their superiority over binary distinctive features in formalizing 'collocational restrictions' or filters excluding unattested segments in different positions.

The discussion of the sonority features (indices) and the major class features (cf. 3.2.1) highlighted the superiority of the former over the latter in stating generalizations about segment organization in natural languages. Yet, in an analysis of the sequential constraints of a given language, it is usually the case that some segments need to be referred to in isolation. That is the natural classes defined by sonority indices do not always behave in a uniform manner. Thus, while two members of a class (e.g. b, d in the O position in ATT), the third element of the same class might not. In this case, it becomes necessary to isolate the segment in question (here: g) from the other two segments. However, as Boukous (1987:345) rightly notes, the sonority indexing scheme cannot provide for such exclusions. This constrained nature of the sonority of the sonority scheme makes it necessary to resort to filters, which serve the function of defining the "exceptions to the conditions" formulated by the use of sonority indices.

Because of the time constraint, we shall not consider the two competing models dealing with the features appropriate in the formulation of these filters (cf. Harris (1983), in Boukous (1987:345)). The necessary filters will be provided throughout chapters IV and V, using the [PA] features and the [n-sonority] features. (For the discussion of the superiority of PA features over the distinctive features in a study of the phonotactics of Berber, cf. Boukous (Ibid)).

As was stated above, in the model adopted by Boukous (Ibid), the articulatory scale is based on the place of articulation of segments: those that are articulated at the back part of the vocal tract are assigned low Place of Articulation features (PA features), and those that are produced at the front part of the vocal tract are assigned high PA features. The hierarchical order of the PA features is based on the relation of one place of articulation of a segment to that of another. Thus, the labials *b*, *f*, *m* have a PA=IO, and the dentals *t*, and *d* have the next lower PA feature (i.e. 9), because their place of articulation is situated next to that of labials. The alveolars *s*, and *z* have a PA feature 8, and so on, until all segments are assigned a PA feature. These features and the segments they define are given in the articulatory scale provided in (19), which is reproduced from Boukous (Ibid:347):

(19)	b, m, f	IO
	t, d, n	9
	s, z, l, r	8
	r	7
	s, z	6
	k, g, i, j, a	5
	x, , u, w	4
	q	3
	h	2
	h	I

To illustrate the superiority of the PA features over distinctive features in capturing generalizations on segment organization in Berber, Boukous (Ibid:662), Chtatou's (1982) positive syllable structure '(30a)', and reformulates it using the PA features.

(20) <u>Positive syllable structure condition (Chtatou, 1982: 231)</u>

$$\begin{array}{ccc} & C_o & \\ C & & C \\ \begin{bmatrix}+\text{nas}\\+\text{cor}\end{bmatrix} & & \left[\begin{array}{c}\begin{bmatrix}-\text{nas}\\+\text{voice}\end{bmatrix}\\ \left[\begin{array}{c}\begin{bmatrix}+\text{cor}\end{bmatrix}\\ \left\langle\begin{array}{c}\begin{bmatrix}+\text{cont}\\+\text{strid}\end{bmatrix}\\ \begin{bmatrix}-\text{cont}\\-\text{high}\end{bmatrix}\end{array}\right\rangle \\ \begin{bmatrix}+\text{back}\\+\text{high}\\+\text{cont}\end{bmatrix}\end{array}\right]\end{array}\right]\end{array}$$

As Boukous (Ibid:662) explains, this condition can be reformulated in a simpler, less costly manner:

(21)

$$\begin{array}{cc} R_1 & R_2 \\ \left[\begin{bmatrix}\text{SON}\\5\end{bmatrix}\ \begin{bmatrix}\text{PA}\\9\end{bmatrix}\right] & \left[\begin{bmatrix}\text{SON}\\4 \geqslant n \geqslant 2\end{bmatrix}\ \begin{bmatrix}\text{PA}\\9 \geqslant n \geqslant 8\end{bmatrix}\right]\end{array}$$

Both conditions generate the same permissible codas, but the second condition is more efficient in that it is simpler and less costly. In view of this alledged superiority of PA features over binary distinctive features, it is necessary to sketch out the motivation for these PA features, and how these are assigned to segments in Berber.

The articulatory scale in (19) does not include geminate segments because these are distinguished from their corresponding single (or simple) segments on the basis of their manner of articulation ([+tense] (or fortis) for geminates and [-tense] or (lenis) for non-geminates) and not on their place of articulation. The liquid r̂ is not present in the scale above since it has no phonemic status in Tashelhiyt, the variety for which (19) is designed. Since this same liquid is included in the phonemic inventory of ATT, and since its articulation is effected in the alveolar ridge (cf. Chap.I., sect. 3), it will be assigned the PA feature 9.

Another remark is in order about the adoption of the articulatory scale in (19) for ATT. Since the intuitive judgements of the native speakers regarding acceptable and unacceptable sequences of segments in ATT are formulated at the phonetic level, it will be necessary to include some more segments in the scale in question. In particular, the spirants B, θ, and ð will have to be included in the scale in question. On the other hand, the pre-palatal affricates ĉ, ĵ, and the palatals ç, y will not be assigned a place in this articulatory scale since they will not be dealt with.

To conclude this section, here is the articulatory scale proposed for ATT in (22):

(22) Articulatory scale of ATT

Segments	PA Features
b, B, m, f	IO
t, d, θ, o, n, f̂	9
s, z, l l	8
r	7
s, z	6
k, g, i, j, a	5
x, ɣ, u, w	4
q	3
ħ, ʒ	2
h	I

II.5 Conclusion

The review of the literature presented in this chapter has demonstrated the following points:

1) Phonotactic constraints are better stated in terms of the syllable than the morpheme or the word (cf. Sect.1

2) A syllable conceived of as a hierarchical unit is more efficient in capturing generalizations about segment organization than a syllable conceived of as a linear arrangement of sounds bounded by syllable boundaries (cf. Sect. 3)

3) The use of sonority indices and place of articulation indices in stating the phonotactics of languages allows for a simpler analysis than the use of binary distinctive features as conceived of in the standard phonology of SPE. (cf. Sect.4).

The relevance of the results mentioned in 2) above to the study of phonotactics in Berber will become clear in Chap. III. Those listed in 1) and 3) will be made transparent by the analysis of sequential constraints in ATT provided in Chapters IV and V.

Footnotes to Chapter II

(1)'consonant set' is our translation of Basbøll's (1974) "partie consonantique" which he defines as follows: "une 'partie consonantique' comprenant zéro, une ou plu plusieurs consonnes" Basbøll (Ibid : 28).

(2) It will become clear (cf. Chap.III) that the minimal utterance is considered as the domain of the operation of syllabification rules.

(3) Hankamer and Aissen (1974) state that evidence for a sonority hierarchy "has been presented in recent work by Foley (1970) (evidence from phonological change), Zwicky(1972) (evidence from fast speech phenomena)" Hankamer and Aissen (Ibid.: 142-143).

CHAPTER THREE

THE SYLLABLE STRUCTURE OF ATT

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III. 0 Introduction

Evidence that the syllable is the appropriate domain for stating phonotactic constraints in natural languages was adduced in Chapter II. It was argued there that segments associated to the same syllable are subject to a universal Sonority Sequencing Generalization (cf. Chap. II, Sect. 3.2.1), and that a number of phonological rules in different languages are better expressed if they are made to refer to the sonority indices of segments rather than to their binary distinctive features. These sonority indices are arranged in a universal Sonority Hierarchy (cf. Chap. II, Sect. 3.2.1) . The sonority hierarchy for ATT was given in the same chapter (Sect. 4).

The object of the present chapter is to attempt to formalize the intuitions of the native speakers of ATT regarding the syllable structure of that variety. This will be done in the light of principles and conditions claimed to be universal. Other principles and conditions special to ATT will be formalized throughout the discussion provided in the present chapter. Its organization is as follows: Section one is concerned with an elaboration of the universal principles of, and conditions on, the syllabification procedure. The syllabification algorithm of ATT is the subject of sections two and three. Due to the problematic status of long segments and high vocoids (i.e. high vowels and their corresponding glides), these are treated in section four, where it is explained that after the application of phonological rules, which might affect syllable structure in various ways, the syllabification algorithm is set to work again to restore the altered syllable structure in conformity with the syllable template and conditions on the terminal positions of the syllable in ATT.

III.1 Universal principles of syllabification

The principles of syllabification and conditions on the syllable structure presented in this section are those observed to be operative in a number of natural languages and claimed to be universal. The relevance of these principles to the analysis of the syllable structure of ATT will become clear throughout the discusion and elaboration of the syllabification algorithm for this variety presented in this chapter. There are at least three types of such principles and conditions: (a) generalizations on segment organization within the syllable,(b) universal association conventions, and (c) universal well-formedness conditions.

a) Generalizations on the syllable terminal positions

It was demonstrated in Chapter II that in a number of works (cf. Jerperson (1904); Vennemann (1972), (1974); Selkirk (1982), (1984), etc.,. it is claimed that, universally, the syllable is made up of a segment with the highest sonority index preceded and/or followed by segments with decreasing sonority indices. This observation was formulated in (Chap; II, Sect. 3.2.1) and is reproduced below for ease of reference:

(1) <u>Sonority Sequencing Generalization</u>

> In any syllable, there is a segment constituting a sonority peak that is preceded and/or followed by a sequence of segments with progressively decreasing sonority values.
>
> (Selkirk (1984:116))

This is a strong claim about segment organization in natural languages. It will become clear (cf. Sect. 3 below) that native speakers of ATT accept syllables where the sonority index of the onset is the same as that of the rime, which necessitates that the claim in (1) be reformulated into a weaker version (cf. III.3). The sonority values (or indices) mentioned in (1) are ordered along a universal sonority hierarchy (cf. ChapII, Sect.3.2.2). The sonority hierarchy adopted for ATT was given in (Chap. II, Sect. 4) and is reproduced in Section III.2 below

b) <u>Universal Association conventions</u>

Since the use of the CV-notation is considered redundant in the present work, there is need to specify what segment to associate with what syllable terminal position. This is one of the major roles of the sonority indexing scheme, which offers a plausible means for associating elements from the melody tier to syllable terminal positions. This is done by the convention given in (2) below/:

(2) <u>Autosegmental Syllable Association Convention</u>

> A segment α of a segmental melody tier may be associated with a terminal position β in a syllable structure only if its sonority index falls within the range specified by conditions on that terminal position and conditions relating it to adjacent positions.
>
> (Selkirk (I984:I24))

The convention in(2) provides conditions on the association of elements from two tiers (the segmental tier and the syllable terminal tier), but it does not specify the order of association of these elements. That is, it does not indicate the segments that the association starts with, and what constituent of the syllable (the onset or the rime) is first associated to elements from the segmental melody tier. Thus, (2) needs to be supplemented with a convention that specifies the order of the association. This convention which is provided in (3) below, is the core syllable association:[1]

(3) <u>Core Syllable Association (CSA)</u>

If C V

Then 6

(Ito (1986:2))

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(3) <u>Core Syllable Association (CSA)</u>

If C V

Then 6

(Ito (1986:2))

We interpret this convention as "Associate a core syllable to a sequence CV." As no underlying distinction between the syllabic and non-syllabic elements is recognized in the present work, the sequence CV will simply mean a sequence XY where Y has a sonority index superior to that of X.[2]

The manner of association dealt with above also necessitates a directionality parameter which specifies whether the association proceeds from left-to-right or right-to-left on a string of segments to be syllabified. This directionality parameter is given in its universal form in (4):

(4) Directionality

Phonological mapping proceeds directionally: left-to-right or right-to-left.
(Ito (1986:2))

The leftward strategy (from right-to-left) is the one adopted in the present work for reasons that will become clear (cf. Sect. III.3).[3]

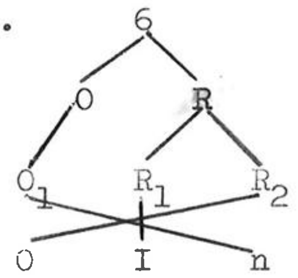
c) Universal well-formedness conditions

The association of elements from the segmental melody tier to syllable terminal positions is governed by the following universal principle (Goldsmith (1976b:36)):

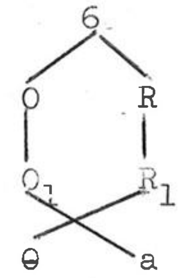
(5) Association lines do not cross:

Thus, the representations in (6 a-c) are ill-formed:

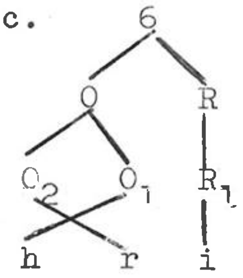
(6) a.



b.



c.



The ill-formedness of the trees in (6a-c) is caused by the crossing lines relating the melody tier to the timing tier. Other well-formedness conditions special to ATT will be provided throughout the analysis presented in the following section.

III.2 A syllabification algorithm for ATT: A preliminary version

The redundancy of the feature syllabic was highlighted in chapter two where it was argued that whether or not a segment is syllabic depends on the position that segment occupies in syllable structure. There are a number of segments attested in various languages which function as [+syllabic] when they are governed by the nucleus node of the syllable and as [-syllabic] elsewhere.

Abercrombie (1967:80) states that "syllabic l and n are found in many languages besides English; syllabic m is found in many African languages; a syllabic trill r is found in Serbian." In addition to the sonorant segments, obstruents can also be syllabic as in the case of Caucasian languages (Anderson (1978); Boukous (1987:189)). Boukous (Ibid) provides a detailed account of segments, other than vowels and sonorants, which can fill the nucleus position in the syllables of Tashelhiyt (cf. also El Medlaoui (1985); Dell and Medlaoui (1985), (1988)).

The observation common to these works is that some utterances are devoid of any vocalic element, traditionally assumed to be the syllable peak 'par excellence'. The same observation applies to ATT. Thus, there is no audible transitory vowel in the forms in(7) below:

(7)	sŝf	'sip'
	tttθ	'you eat. Int. pl'
	tttfθ	'you catch. Int. pl'
	sfsi	'make sth melt'

In careful speech, however, a vocalic transition is audible especially close to voiced segments: thus the forms in (7) can be transcribed either as in (8a) or (8b) depending on the rate of speech.[4]

(8)	Underlying Forms	a. Careful Speech	b. Normal Speech	Gloss
	θ+r̂qa	θər̂qa	θr̂qa	'she met'
	a#t+mr̂ŝ+ð̂	atmər̂ŝð̂	atmr̂ŝð̂	'you'll get married'

θ+çθi θəçsi θçsi 'she lifted'

To illustrate that the problem of the transitional vowel is not special to ATT, we quote Dell and El Medlaoui (1985: 116) who state that in Imdlawn Tashelhiyt

> In syllables with only voiceless consonants, there is nothing in what one hears which cou could suggest the existence, adjacent to the syllabic consonants but not to the others, of a voiceless vowel.

The same authors provide the forms utẋk 'I struck you', and tšti 'she selected' and other ones to illustrate their claim.

Despite the lack of experimental evidence, which adds to the elusive nature of the schwa vowel -or reduced vowel- it can be said that this vowel in (8a) is not as audible as the one in the French forms below pronounced carefully:

(9) lə (le) 'a'

sə (ce) 'this, Masc.'

pəti (petit) 'small, Masc.'

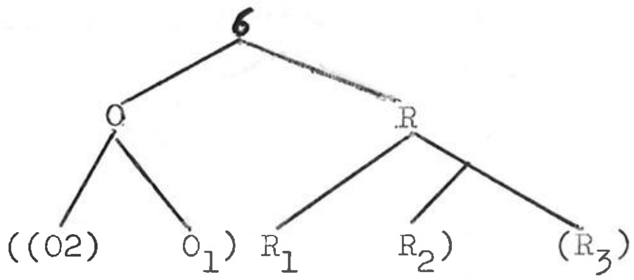
The corollary result of disregarding the schwa as a vocalic element to fill the nucleus position in a syllable with no plain vowel is that some strings of ATT are totally devoid of any vowel, and the syllabification algorithm of ATT will assign the nucleus position to segments other than vowels. As we shall in the following section (see below) all segments in ATT (except for glides) are eligible for syllabicity.

III.2.1 The syllable template of ATT:

In providing the syllable template of ATT and the sonority conditions, we also illustrate the behaviour of syllabic segments. Below, we provide instantiations of the syllable template with syllables which have a full vowel in the nucleus position (cf. 11a), as well as syllables where the nucleus position is filled with segments other than vowels (cf. 11b). The syllable template of ATT is given in (10a) and the sonority conditions implied in the Sonority Sequencing Generalization (1) are given in(10b):

(10) ATT Syllable Template: [5]

a.



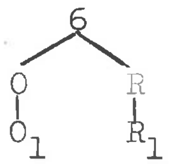
b. $SI(O_2) > SI(O_1) > SI(R_1) < SI(R_2) < SI(R_3)$

The obligatory constituent of the syllable is the nucleus, or the R_1 position. All other slots can be null. Equivalently, the minimal syllable is the one where the R_1 position is associated to a segment from the melody tier and where the onset as well as the R_2 and the R_3 positions are empty.

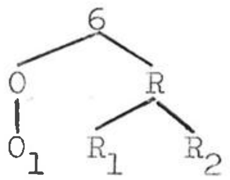
The syllable template in (10) is the set of all possible syllable representations in ATT. These syllable representations are partial instantiations of the general template in (10) as shown in (11):

(11) (i) 

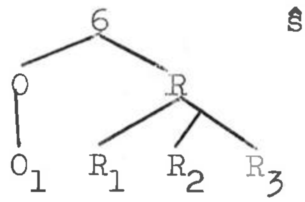
a. a 'hey!' b. x 'on'

(ii) 

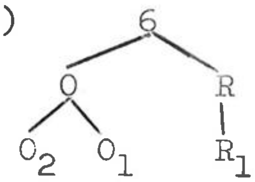
su 'drink' sɣ 'buy'

(iii) 

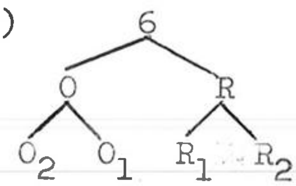
θin 'that one' mf̂ŝ 'marry'

(iv) 

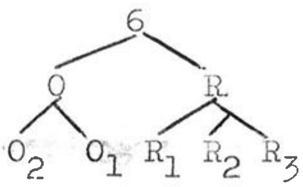
ŝ:int 'they ate' θf̂mð 'she learnt'

(v) 

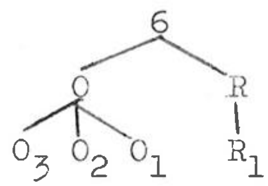
hwa 'go down' qff̂ 'close'

(vi) 

ð̌wint 'they Fem. flew' ð̌wf̂d 'come back'

(vii)  θfawt 'light' qff̂nt[6] 'they're closed'

The syllable trees and the syllable template in (10) do not explain how syllables are built in ATT. They merely exemplify the set of possible syllable structures allowed in the variety under study. Thus, a syllable tree as the one in (12) is ill-formed because it does not conform to the syllable template (10):

(12) 

To explain how syllables are built in ATT is the task of the following sections (Chap. III, Sect. 2-4).

Before proceeding to the operation of syllabification rules, it should be pointed out that the maximal domain of syllabification is a string of segments within which no pause can be inserted.[7] For example, the forms in(13a) are a maximal domain of syllabification, whereas those in (13b) are made up of more than one domain (namely two):

(13) a.	aman	'water'	b.	aɣrum inu	'my bread'
	θndụ	'she jumped'		θndu xas	'she jumped on it'
	tmsxBaŝnt	'they scratch-each other'		xBŝ θin	'scratch that one'

III.2.2 Core syllabification

Given a string of segments in ATT specified for their sonority indices, the first principle that operates to build syllable trees is the core syllabification principle. This principle was given in its universal form in(3) above. To be functional in ATT, core syllabification needs to be supplemented with some conditions that show clearly which element in a string of segments is to fill the nucleus position and which is to fill the onset position. This is so because in the present analysis segments that are the input to syllabification are not specified by the [+syl] feature. These conditions are cast in the form of sonority indices as shown in (14), which is an elaboration of CSA(3) given above:

(14) Core syllabification

> Given a string of segments specified for their sonority indices in ATT, build a core syllable XY (O_1R_1) where X is any segment and Y has a sonority index superior to that of X.

It should be added that CS(14) does not apply to previously syllabified segments. To formalize this observation, we reproduce Dell and El Medlaoui's (1985: 111)convention:[8]

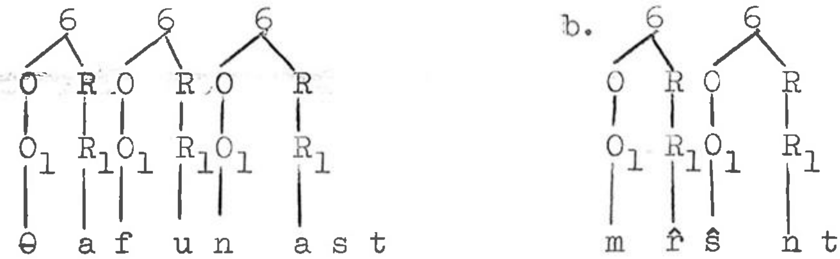
(14') CS Core Syllabification can build syllables only over (Y)Z sequences where neither Y nor Z has been syllabified

CS(14) will assign the forms in (15) the syllable representations in (16):

(15)

a.	θ	a	f	u	n	a	s	t	(segments)	b.	m	f̂	ŝ	n	t
	3	8	3	7	5	8	3	1	(sonority indices)		5	6	3	5	1

(16) a.



III.2.3 <u>Coda Assignment</u>

The last two elements in **the** form in (15a.) (i.e. <u>s t</u>) cannot form a core syllable since the sonority index of <u>s</u> (henceforth SI (s)) is superior to that of <u>t</u> (i.e. SI (s) > SI (t)). With respect to the last element in the second form (i.e. <u>t</u>), there is no element on its left to fill the O_1 position (or to function as an X in a sequence X Y). Moreover, the segments in question cannot be extra-syllabic, in view of the well-formedness condition that rules out extra-syllabic segments in ATT, which is given in (17) below:

(17) Extra-syllabic elements are not allowed in ATT

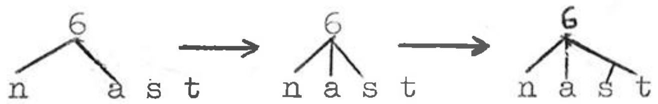
After the operation of core syllabification, another rule takes effect to adjoin the unsyllabified segments to the preceding syllables. This rule is the coda assignment formalized in (18) below:

(18) <u>Coda Assignment</u>

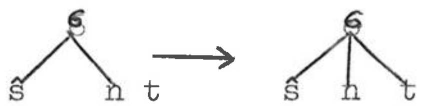
> Assign any segment unsyllabified by (14) to the syllable on the left to form an element of the rime of that syllable.

This rule applies whenever its structural description is met. In this way, it first assigns the segment <u>s</u> in (19a), and the segment <u>t</u> in (19b) to the syllables on their left, and applies again to assign <u>t</u> in (19a) to the syllable on its left as shown below: [9]

(19) a.

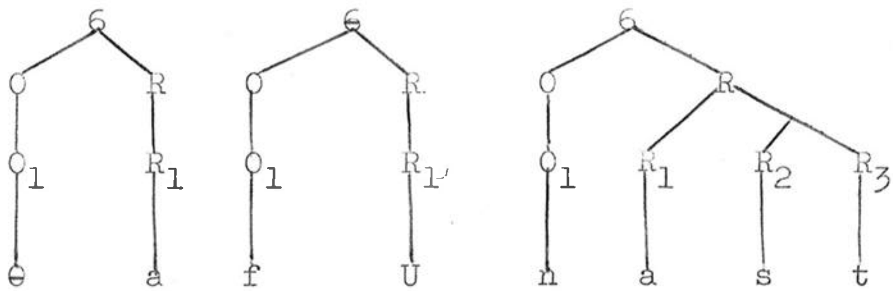


b.

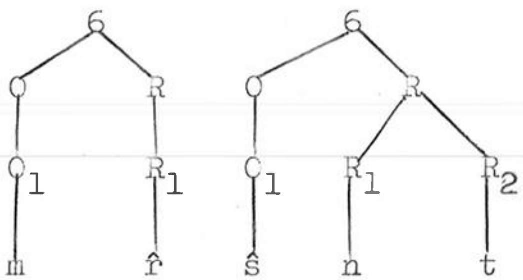


The full syllable representation of the forms in (19a,b) is schematized as in (20a,b) below:

(20) a.



b.



III.3 A syllabification algorithm for ATT: a revised version

Although the application of CS(14) and CA(18) yields acceptable syllable representations for the forms in (20 a.,b.), CS(14) cannot syllabify the forms in (21) below:

(21) x s 'like'

n m s ħ 'we wiped'

ɣ z 'dig'

III.3.1 Revised core syllabification

CS(14) cannot apply to the forms in (21) above since there is no sequence X Y where SI(Y) > SI(X). The scansions of the native speakers of ATT for the forms in question are given in (22) below:

(22) x s n m.s ħ ɣz

The scansions in (22) above show that native speakers of ATT accept syllables where the sonority index of O_1 is equal to the sonority index of R_1 ($SI(O_1)=SI(R_1)$). This implies that CS(14) needs to be revised in order to account for the forms above, and other similar ones. That is, CS(14) needs to state that the two elements of a core syllable can have the same sonority index. The revised core syllabification is given in (23):

(23) Core Syllabification

> Given a string of segments specified for their sonority indices, build a core syllable XY ($O1R_1$) on a sequence X Y, where X is any segment and Y has a sonority index superior or equal to that of X.

The application of CS(23) to the forms in (22) yields the acceptable syllable representations given below:

(24) σ (x s) σ (n m) σ (s h) σ (ɣ z)

III.3.2 Onsetless syllables

Further investigation of data from ATT uncovers the necessity to add a special proviso or condition on syllables immediately following a pause. In (25) are some examples that show the inadequacy of the principles formulated so far to assign syllable structure to all forms in ATT:

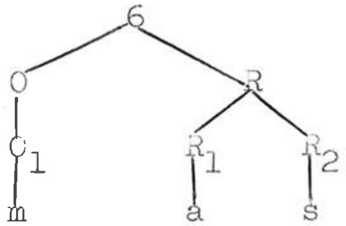
(25) a. ini 'say' b. anu 'well' c. umas 'his brother'

By core syllabification (CS) the forms in (24a -c) are assigned the following syllable representations:

(26) a. I σ (n I) b. a σ (n U) c. u σ (m a) s

Coda assignment adjoins s to the core syllable in(26c), resulting in the structure in (27):

(27)



The initial segments in (26a-c) cannot be assigned to the syllable on the right because their sonority indices are higher than those of the elements filling the O_1 position. The prohibition against such configurations where the SI of O_2 is superior to the SI of O_1 was formulated in (10b).

In conformity with the intuitions of the native speakers of ATT, the forms in (25a-c) are made up of two syllables each, as shown below:

(28) a. i.ni b. a.nu c. u.mas

That is, native speakers of ATT judge onsetless syllables immediately following a pause as acceptable. In fact, this is not a special characteristic of ATT; El Medlaoui (1985, 1988) and Boukous (1987) report the same observation about Tashelhiyt varieties; the ITB variety and the PA variety respectively.

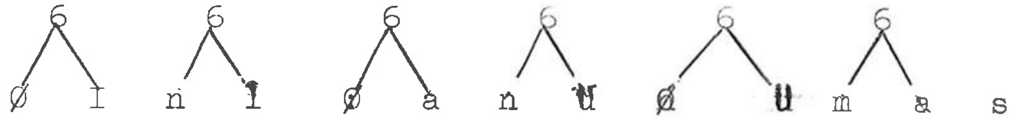
This observation can be formulated as in (29) to allow CS (23) to build nuclear syllables with a null onset exceptionally after a pause:

(29) In post-pausal syllables, the onset is optional.

It should be pointed out right at the beginning that, during its application, core syllabification takes into consideration the fact stated in (29). That is, it can build a nuclear syllable with a null onset if the syllable in question immediately follows a pause.

With principle (29), core syllabification applies to the forms in (25a-c) to yield the following representations:

(30) a. ini b. anu c. umas



Coda assignment applies to adjoin s to the second syllable in (30c) as shown in (31):

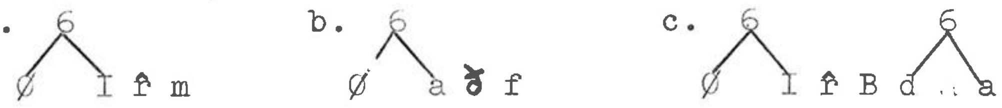
(31)

The condition in (29) makes it possible to account for onsetless syllables after a pause. Still, there is a number of forms in ATT which cannot be syllabified by CS (23) and the condition in (29). These forms display strings of up to three segments which cannot by syllabified by the principles elaborated so far, as shown below in (32):

(32) a. ir̂m 'skin' b. aðf 'go in' c. ir̂Bda 'forever'

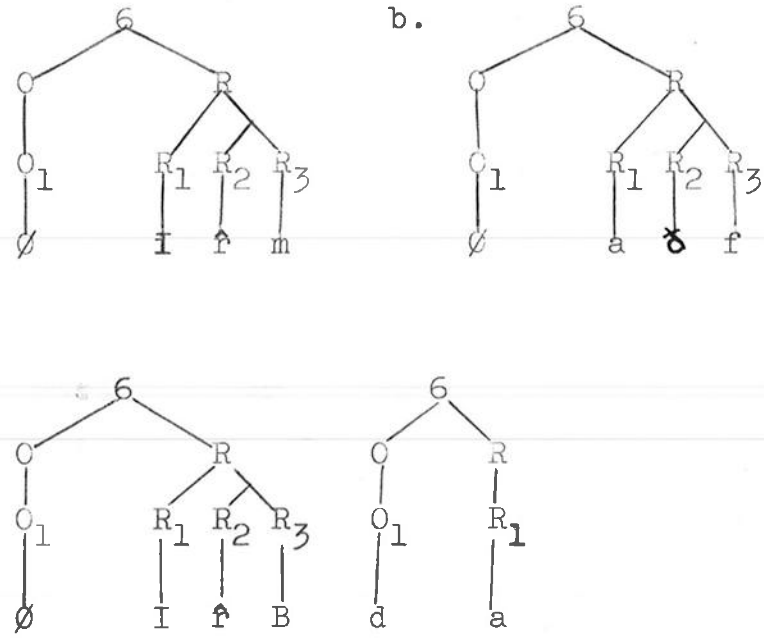
To illustrate the insufficiency of the principles elaborated so far in assigning syllable representations to the forms in (32), here are the scansions yielded by CS (23) in (33):

(33) a. b. c.



Since there is no sequence of two segments XY where the SI (Y)$\gg$SI (X), and since none of the unsyllabified segments in (33) is post-pausal to be eligible for syllabicity with a null onset, CS (23) does not take effect anymore. The segments not syllabified in these forms cannot be extra-syllabic since this is ruled out by (I7) above. CA (I8) automatically groups the unsyllabified segments in each form with the preceding syllable and yields the following unacceptable representations:

(34) a. b. c.

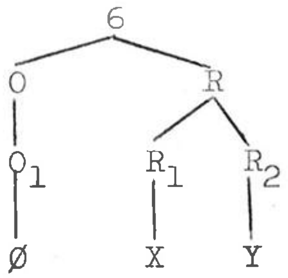


The representations in (34a-c) are ill-formed because they do not conform with the intuitions of the native speakers of ATT which are formalized below:

(35) a. i.f̂m b. i.f̂B.da c. a.ð̌f

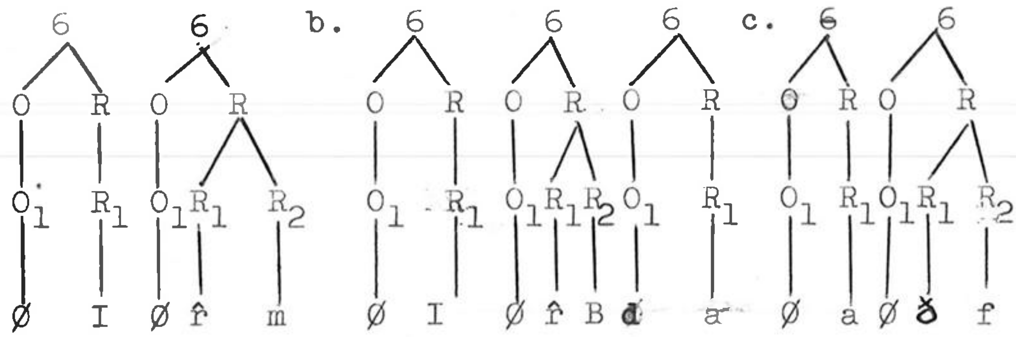
The representations in (35) suggest that in ATT onsetless syllables word-internally, or in the middle of the syllabification domain, are acceptable since the second syllable in each of the forms in (35) above consists of a sequence X Y where the SI (X) > SI (Y). This shows that, in each instance, it is the first element and not the second one which is the nucleus of the syllable.[10] That is, in a sequence X Y left unsyllabified by CS (23), X can stand as an onsetless syllable. After that, CA (18) adjoins Y to X to yield a representation of the following form:

(36)



Thus, the forms in (32a-c) are given the following representations:

(37) a.



The principle capable of generating the forms in (37a-c) might be formulated as follows:

(38) After the operation of CS (23), build a core syllable with a segment X in the nucleus and a null onset on a sequence X Y unsyllabified by CS (23) (where SI (X) > SI (Y)).

The ordering of (38) after CS (23) and before CA (18) yields the representations in (37a-c) above.

Further data from ATT show that principle (38) above yields unacceptable syllable representations. The forms in question display up to three segments which cannot be syllabified in conformity with the intuitions of the native speakers of ATT. The data in (39) below illustrate some of these forms:

(39) a. f̂mðθ 'learn (you Pl.)'

b. inzf 'he is exhausted'

c. af̂mθ 'you Pl. mend clothes'

The application of CS(23), principle (38), and CA(18) to these forms yields the unacceptable representations given below:[11]

(40) a. ∅f̂.∅m.∅ðθ b. ∅I.∅n.∅zf. c. ∅a.∅f̂.∅mθ

These representations do not match the intuitions of the native speakers of ATT, which are represented in (41)

(41) a. f̂m.ðθ b. in.zf c. af̂.m<u>θ</u>

It seems, therefore, that it is the second element in each sequence XYZ unsyllabified by CS(23) (i.e. Y) which constitutes a core syllable with a null onset, a fact overlooked by (38). This leads us to suggest (42) which takes into consideration the above observation instead of (38):

(42) After the operation of CS(23), build a core syllable with a segment Y in the nucleus and a null onset on a sequence (X)YZ unsyllabified by CS(23) (and where X is optional).

By the application of principle (42), the forms in (39) above will be assigned the proper syllable representations, as shown in (43) below:

(43)	a. f̂mð̂θ	b. inzf	c. af̂mθ
CS(23):	Ø f̂ m ð̂ θ	Ø I n z f	Ø a f̂ m θ
by(42):	Ø f̂ m Ø ð̂ θ	Ø I n Ø z f	Ø a f̂ Ø m θ
CA(18):	Ø f̂ m Ø ð̂ θ	Ø I n Ø z f	Ø a f̂ Ø m θ
Final output:	f̂m.ð̂θ	in.zf	af̂.mθ

Although the forms in (39) are assigned syllable representations that conform to the intuitions of the native speakers of ATT (compare (41) with the final output in (43)), the data in (44) below show that the principles elaborated so far generate unacceptable syllable representations;

(44)	a. uzanθ 'they ~~skinned~~ him'	b. ufinθ 'they found him'
CS(23):	Ø U z a n θ	Ø U f I n θ
by(42):	Ø U z a Ø n θ	Ø U f I Ø n θ
CA(18)	Ø U z a Ø n θ	Ø U f I Ø n θ

Final output: *u.za.nθ *u.fi.nθ

The final output in (44) above does not conform to the intuitions of the native speakers of ATT which are formalized in (45):

(45) a. u.zanθ b. u.finθ

By looking at the segments constituting the sequences YZ in the forms in (44), one might conclude that when the segment Z is θ, principle (42) is blocked and the sequence YZ is grouped with the syllable on the left to be a coda cluster. This conclusion is immediately contradicted by the data in (46):

(46) a. qimθ 'sit down'you, Pl.'
b. ʒanθ 'push you, Pl'
c. sa:sθ 'put down you, Pl.'

The sequences mθ, sθ, and nθ are judged to be independent syllables by the native speakers of ATT as shown in (47):

(47) a. qi.mθ b. ʒa.nθ c. sa:.sθ

A comparison of the forms in (47) with those in (44) suggests that it is the morphemic function of θ which determines whether a sequence Xθ (where X is m, n, and s in (47) is an independent syllable or it is adjoined to the syllable on the left to fill the R_2R_3 positions. In (44) θ is the clitic object, and in (46) (and (47)) it is the clitic subject. Thus, a condition with the effect of stating that when θ is the plural clitic subject in a sequence Xθ, the sequence Xθ is syllabified by principle (42); otherwise, the sequence Xθ is adjoined by CA(18). This condition is given in (48) below:

(48) In a sequence (X)YZ unsyllabified by CS(23),

if Z = $\begin{bmatrix} \theta \\ \text{+subject} \end{bmatrix}$

then σ

Ø Y Z

Additional data from ATT suggest that the problem at hand is not characteristic of the coronal θ, but rather, concerns the coronal stops t and d as shown below:

(49) usind 'they came'

ufint 'they found'

The application of CS(23) and CA(18) to the forms in (49) above will yield unacceptable results as shown in (50):

(50) usind — ufint

CS(23): Ø U s I n d — Ø U f I n t

by(42); Ø U s I Ø n d — Ø U f I Ø n t

Final output: *u.si.nd *u.fi.nt

The forms in (50) above are judged as disyllabic by the native speakers of ATT, as shown in (51):

(51) u.sind u.fint

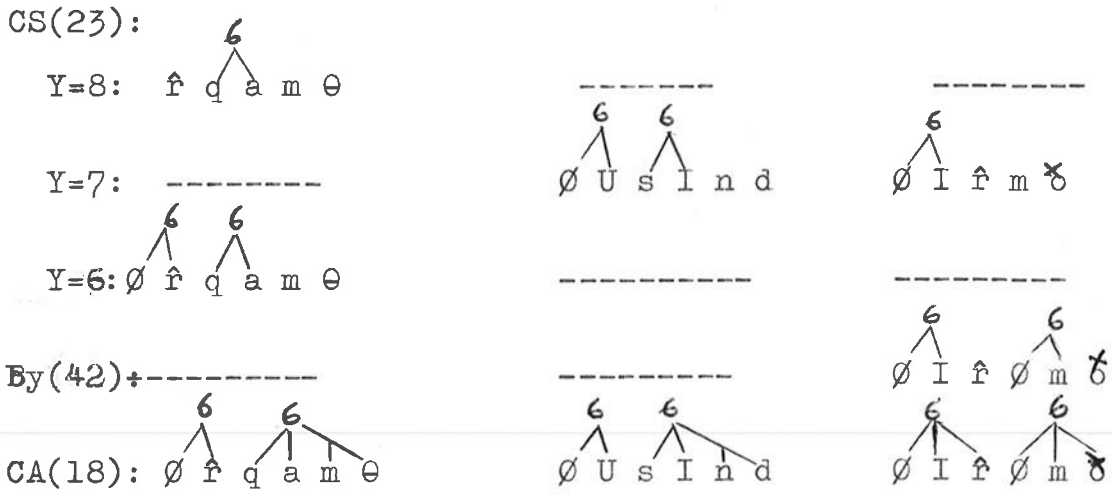
A comparison of (50) with (51) suggests that the segments t and d which function as Z in the sequence XYZ are simply grouped with the preceding syllable to fill the R_3 position. This condition holds only when <u>t</u> or <u>d</u> occur at the end of the syllabification domain. This is so because sequences YZ where Z=<u>t</u> or <u>d</u> function as independent syllables when they occur at the begenning or at the end of the syllabification doamin, as illustrated in (52) below:

(52) nt.tu 'we forgot'

a.nd.da 'we will live'

To illustrate the efficiency of the principles and conditions elaborated so far in assigning appropriate syllable representations to ATT forms, consider the instances in (53) and how they are syllabified:

(53) a. r̂qamθ 'meet him' b. usind 'they came' c. ir̂mɣ̆ 'he learnt'



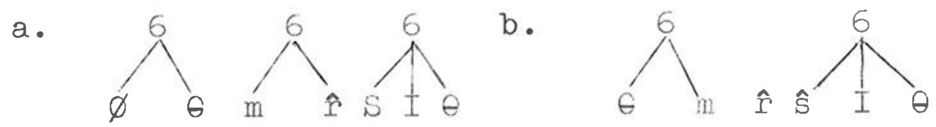
Final output: r̂.qamθ u.sind ir̂.mɣ̆

Principle (42) does not apply to (53a) since <u>θ</u> is not a clitic subject. In (53c), the segment <u>r̂</u> is syllabified with the syllable on its left since it functions as an X in a sequence XYZ.

III.3.3 <u>Ordering core syllabification</u>

In testing the principles of syllabification elaborated so far against further data from ATT, one immediately notes the competing syllable representations in(54a) and (54b). An additional principle is needed to constrain the syllabification algorithm from yielding syllable representations such as those in (54b):

(54) θmr̂ŝiθ 'she got married to him'



The representation in (54a) conforms with the syllable template of ATT whereas the one in (54b) does not. In the latter form, the segment <u>r̂</u> cannot be adjoined to the coda of the preceding syllable (or the R_2 position) because its sonority index is higher than that of the nasal <u>m</u> which fills the nucleus position. Nothing has so far been said to prevent an output of the syllabification algorithm like the one in (54b), so there is a need for an additional principle, which orders the application of core syllabification:

(55) Core syllabification operates first on sequences XY where Y has the highest sonority index in a string of segments and then proceeds to another sequence XY where Y has the next lower sonority index.

Thus, there are a number of ordered passes of core syllabification (El Medlaoui (1985); Dell and El Medlaoui (1985), (1988); El Medlaoui (1988)) as illustrated below, which assign the string θmr̂ŝiθ the proper syllable tree:

(56) θ m r̂ ŝ I θ 'she got married to him'
     3 5 6 3 7 3

2nd Pass: SI (Y)= 7:

6

θ m r̂ ŝ I θ

3rd Pass: SI (Y)= 6

6 6

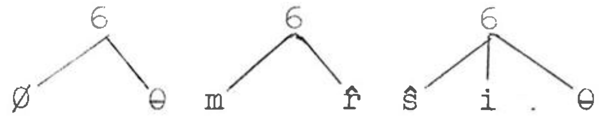
θ m r̂ ŝ I θ

6th Pass: SI (Y)= 3

6 6 6

Ø θ m r̂ ŝ I θ

There is no segment with a SI=8 in the form in (56) above, so CS(23) proceeds to the next step where SI(Y)=7. As there are no segments with a SI=5 or 4, CS(23) proceeds to the next step where the SI(Y)=3. At this stage, and there being no segment eligible to function as Y in the core syllable XY, and no sequence XYZ (to be syllabified by (42)) CS(23) stops operating, and CA(18) adjoins the segment θ to the syllable on its left to yield the final representation in (57) below:

(57) 

III.3.4 Directionality

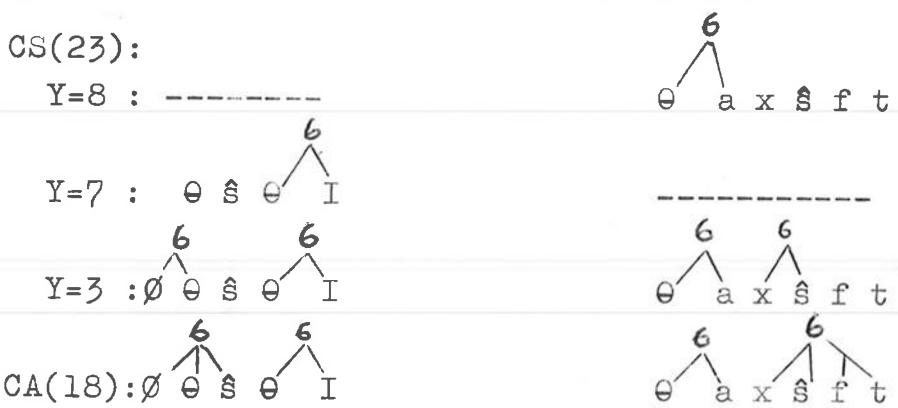
In addition to principle (55) which orders the application of CS(23), a parameter of directionality must be specified for ATT. It was stated when we presented (4) above that languages specify the directionality of syllabification rules either as left-to-right or right-to-left (i.e. the rightward strategy and the leftward strategy, respectively; c.f. Boukous (1987: 243) and references cited there).

Evidence for the superiority of the leftward strategy over the rightward one in ATT is provided by the examples in (58):

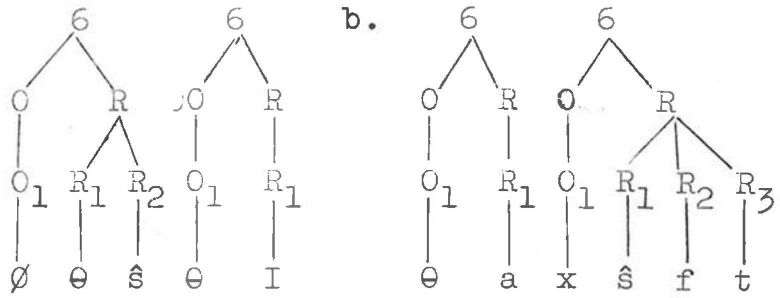
(58) a. θŝθi 'she lifted' b. θaxŝft 'a trap'

CS(23) applying from left to right yields the representations in (59):

(59) a. θ ŝ θ I b. θ a x ŝ f t



Final output: a. b.



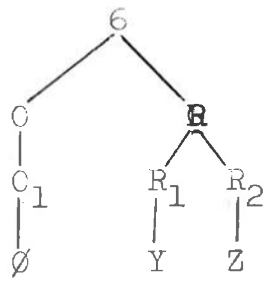
Comparing the final output in (59) with the syllable scansions produced by the native speakers of ATT given in (60) shows the deficiency of these representations:

(60) a. θŝ.θi b. θax.ŝft

Although it is difficult to elicit the judgements of the native speakers as to which segment is the nucleus in a syllable, their intuitions were uniform as to the syllable boundaries indicated in (60) above, which shows the disparity between their representations and those yielded by the syllabification algorithm of ATT (compare (59b) with (60b)).

In addition to the lack of conformity between the representations resulting from the algorithm of syllabification and those representing the intuitions of the native speakers of ATT, there is a second argument, based on the preferred syllable structure, which shows the superiority of the leftward strategy over the rightward one. It is reported in a number of works that the least marked syllable structure, i.e. the preferred syllable structure is CV (Jakobson, et al (1963); Clements and Keyser (1983:28), Boukous (1987:243) and references cited there). Thus, languages may have the CV syllable structure without having the VC one. The reverse, however, is not true: there is no known language which has the VC syllable structure without having the CV one. In the case of ATT, the rightward strategy yields the marked syllable structure VC (or (61) in our notation):

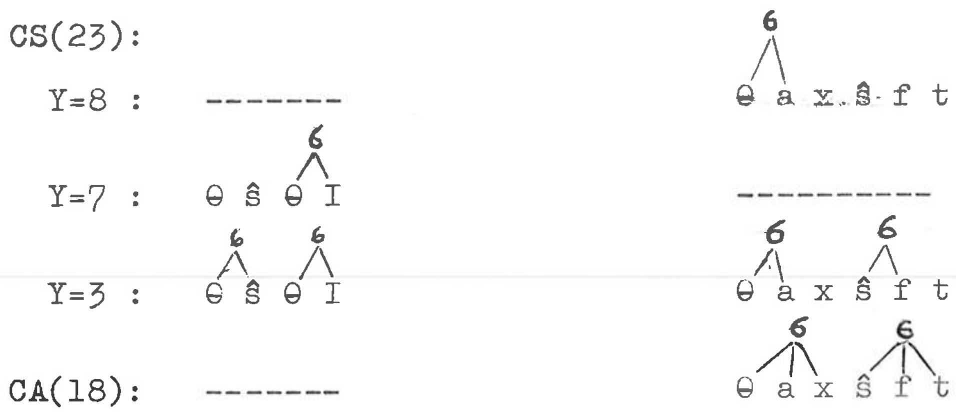
(61)



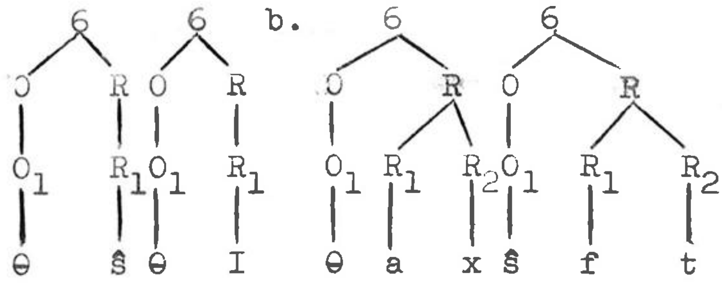
whereas the leftward strategy yields the preferred CV syllable structure.

To illustrate, this is how the leftward strategy will scan the forms in (58):

(62) a. θ ŝ θ I b. θ a x ŝ f t



Final output: a. b.



Needless to say that a comparison of the syllable representations in (59) and (62) with those in (60) shows that the leftward strategy yields representations in conformity with the intuitions of the native speakers of ATT (especially with respect to form (58b)).

The application of the syllabification algorithm to forms containing long segments (long vowels and geminates) has not been illustrated so far. These are treated in a separate section in view of their special behaviour towards syllabification rules, especially geminate segments (cf. section III.4 below).

III.4 <u>Some applications of the syllabification algorithm</u>

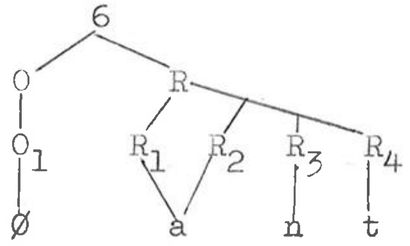
The discussion provided below is concerned with the representation of long vowels and geminate segments. It is argued here that long vowels are associated to one syllable terminal position. With respect to geminates (or long segments), the position defended here is that they behave like sequences of two identical segments in the middle of the syllabification domain (or utterance-medially), and like single (but long) segments at the beginning and end of the syllabification domain.

III.4.1 The syllabification of long segments

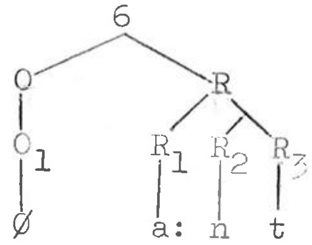
a) Long vowels

Long vowels are represented here on a par with short vowels: they fill only one syllable terminal position at the timing tier. As will become clear in Chapter IV, such a representation is motivated by the observation that it captures significant generalizations on the structure of the rime. If vowels are allotted one position in the timing tier, the rime constituent of the syllable in ATT will have three positions (viz. R_1, R_2, R_3), and the generalization that the R_3 position hosts [+cor] segments will not be contradicted (cf. Chap. V, Sect. V.3). On the other hand, if long vowels are allowed to fill two positions in the timing tier, it will involve a disjunction in the statement of generalizations about the rime structure: It will be necessary to state that the R_3 position is filled by [-cor] segments if the R_1 and the R_2 positions are not associated to a segment with a sonority index superior to 6, i.e. vowels. Moreover, there will have to be an R_4 position which would be functional only if there is a long vowel in the rime. To illustrate, here is how the form a:nt 'you. Fem. pour' will be represented in (63a) if long vowels are allowed to fill two syllable terminal positions, and if they are allowed to fill one syllable terminal position, the forms in question will be represented as in (63b):

(63) a.



b.



In the light of the above discussion, long vowels will be represented as in (64) below:

(64) X
|
V: (Where X is a syllable terminal position)

The problem of the representation of length discussed above is not special to vowels: geminate segments in Berber present similar, if not more complicated, problems to which we turn below.

b) <u>Geminates</u>:

Boukous (1987:326) treats lexical geminates in the same fashion as simple segments with respect to the number of positions they fill at the syllable terminal level. That is, lexical geminates occupy one single position at the timing tier. Differently from Boukous (Ibid), El Medlaoui (1988b) argues that the different types of geminates occupy two positions at the syllable terminal position level. In the present analysis, the position which is defended is that lexical geminates behave like sequences of two segments in the middle of the syllabification domain, and like single (long) segments at the edges of the syllabification domain, i.e. at the end and at the beginning of the syllabification domain.[19] This dual behaviour of geminates regarding syllabification rules is supported by the data in (65):

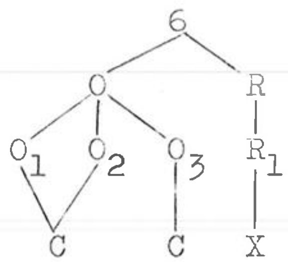
(65) ttBa.j 'habits'

ddfu.jan 'caftans'

ttfajj 'catch me'

The first two forms are disyllabic, and the third one is monosyllabic according to the judgements of the native speakers of ATT. If the geminate segments in these forms are allowed to fill two syllable terminal positions, the result will be a complex onset with three positions. Yet, as was the case with long vowels, this complex onset would be functional only when the first and the second terminal positions in the onset constituent are associated to a geminate segment, as shown below:

(66)



Such a partial template would be valid exclusively for syllables which have a geminate segment followed by another segment in the onset constituent. Thus, instead of imposing a condition on the syllable template of ATT which would state that a complex onset is to be filled with a geminate segment followed by another segment, it is preferable to represent lexical geminates as long segments filling one syllable terminal position as shown in (67):

(67) X
|
C: (where X is a syllable terminal position).

That lexical geminates behave like sequences of two segments in the middle of the syllabification domain is illustrated by the data in (68):

(68)	θk.kim	'you went by'
	θg.gim	'you did'
	θs.Bd.dm	'you made (Sth.) stop'

Additional evidence for the analysis presented above is given by an illustration of the application of the syllabification algorithm of ATT to the forms below:

(69) a.iqdd 'he is capable' b. iBŝŝ 'he urinated'

CS(23):

	a.	b.
Y=7	σ[Ø I] q dd	σ[Ø I] B ŝŝ
Y=4	Ø---------	σ[Ø I] σ[Ø B] ŝŝ
Y=2	σ[Ø I] σ[q d] d	-------------

Final output:	Ø i . q dd	Ø i.B ŝŝ

The output of the syllabification algorithm in (69) above is in conformity with the intuitions of the native speakers of ATT given in (70) below:

(70) a. i.qdd　　　　　b.i.Bŝŝ

By contrast, if the geminates in the forms above were treated like sequences of two segments, the outcome of the syllabification algorithm would be unacceptable as illustrated below:

(71)	a.iqdd	b. iBŝŝ
CS(23):		
Y=7	Ø I q d d	Ø I B ŝ ŝ
Y=3	----------	Ø I B ŝ ŝ
Y=2	Ø I q d d	----------
CA(18):	Ø I q d d	Ø I B ŝ ŝ
Final output:	*i q.d d	*i B.ŝ ŝ

The output of the syllabification algorithm in (71) does not conform to the intuitions of the native speakers in (70).

III.4.2 The syllabification of high vocoids:

As stated in section (I.2.1), the status of high vocoids in ATT cannot be straightforwardly deduced from the position of these segments in syllable structure. The observed generalizations about high vocoids surfacing as high vowels (i, u) or as glides (j, w) for various languages (see Guerssel(1986) and references cited there) is only partially true of ATT (and Berber in general (El Medlaoui (1985), (1988b); Guerssel (1986); Boukous (1987)). In the variety under investigation, the distribution of high vowels and glides cannot be explained by reference to syllable structure alone. That is, it is an over-simplification of the facts of ATT to say that high vocoids surface as high vowels when they are dominated by the R_1 node (equivalently, when they fill the nucleus position), and as glides when they are dominated by other nodes (O_1, O_2, R_2, R_3). As will be seen below, at least three classes of high vocoids (HVs) in ATT will have to be distinguished: a) glides that alternate with high vowels, b) HVs that surface as high vowels unpredictably, and c) HVs that uniformly surface as glides.

a) High vowels and glides in alternation

There is a class of high vocoids in ATT which behaves in conformity with the generalization mentioned above, namely that they surface as high vowels when they function as syllable nuclei and as glides when they are elements of the syllable margins. The data in (72) are given to illustrate this class of segments:

(72) a. jura 'he wrote' b. iqðwit 'he cut it'

Applying the syllabification algorithm (cf. Sect.3) to the two forms above yields the unexpected result:

(73) CS (23):

Y= 8	I U r a	
Y= 7	I U r a	Ø I q ð U I t
Y= 4	————	Ø I q ð U I t
CA (18):		Ø I q ð U I t
Final Output:	j u . r a	q ð . w i t

b) <u>Unpredictable alternation of high vowels and glides</u>:

The testing of the syllabification algorithm against further instances of high vocoids shows the particular behaviour of the second class of high vocoids. To illustrate, here are some forms and their syllabification in (74):

(74) a. iwθa 'he hit' b. iwzan 'type of couscous'

CS (23):

```
                 σ                    σ
                / \                  / \
Y= 8       I U θ a             I U z a n

            σ    σ              σ    σ
           / \  / \            / \  / \
Y= 7       I U θ a             I U z a n

                                σ    σ
                               / \  /|\
CR (18):   ________            I U z a n
```

Final Output: *j U .θ a *j U ,z a n

It is obvious enough that choosing the rightward directionality would have resulted in the correct syllabification of the forms in (74) but in an incorrect one for the forms in(72). Thus, a change of the choice of directionality adopted here (leftward strategy) will bring no solution for the problem at hand. A provisional solution to align the behaviour of the high vocoids in (74) with the common observation about the complementary distribution of glides and high vowels is provided in Guerssel (1986).

Guerssel's (1986) focal point is that some high vocoids will be attached to rime heads (R_1 position) underlyingly whereas others will be left unassociated to rime heads. The former will surface as high vowels whereas the latter will surface as glides or high vowels, depending on the syllabification rules. Obviously, this involves a contradiction: The feature syllabic, interpreted as a redundant one at the underlying level, is simply included in the lexicon in a different manner: association to rime heads. Still, Guerssel (Ibid:1) states that such a solution does not run contrary to the observation that "the distinction between glides and high vowels is strictly a function of syllable structure," and that " this does not imply the necessity of the feature syllabic ."

Following Guerssel's proposal, the forms in (74a,b) will receive the following representation and syllabification:

(76) Underlying representation:

a. R_1 | I+UΘa   b. R_1 | IUzan

Knowing that core syllabification (23) operates on segments not associated with syllable structure this is how the forms in question will be syllabified:

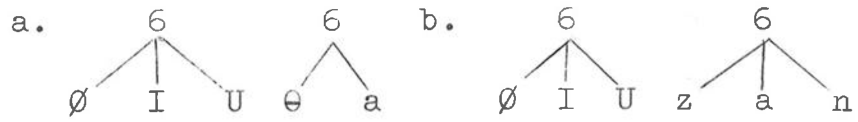
(77)

CS(23):

Y=8 : $\overset{R_1}{\text{I}}$ U $\overset{\sigma}{\wedge}$ Θ a $\overset{R_1}{\text{I}}$ U $\overset{\sigma}{\wedge}$ z a n

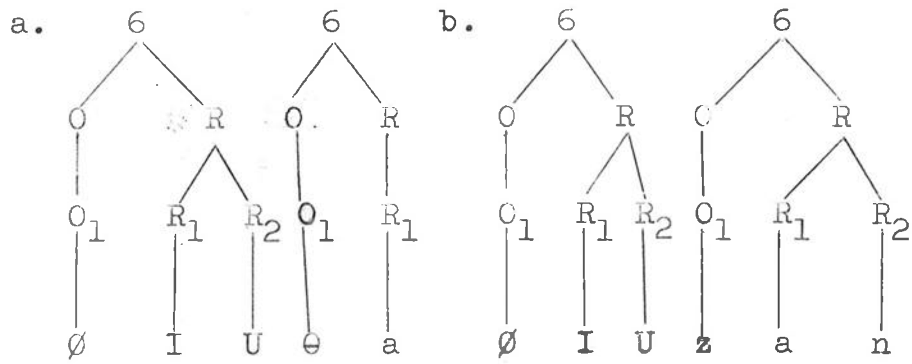
In the forms above U cannot be syllabified because there is no unsyllabified segment on its left to serve as an X in the sequence XY and at the same time, U is not eligible to be syllabified by principles (29) or (42). Thus, the following step is CA(18):

(78)



The full syllable representations of these forms are given in (79) below:

(79)



The high vocoids governed by the node R_2 in the above representations will be realized as glides:and the forms in question will have the following phonetic representations (80):

(80) a. iwθa b. iwzan

The solution proposed for the class of high vocoids discussed above simply states that some high vocoids should be marked for syllabicity without extending this feature to other segments. Its importance lies in the fact that it uses association lines which render the feature syllabic unnecessary. However, such a solution involves an overlap of the syllabification rules and the convention of associating rime heads to the high vocoids in question.

c) Non-alternating glides

There is a class of glides in ATT (and other Berber varieties) which cannot be accounted for by the principles and conventions of syllabification elaborated so far in this chapter. The behaviour of this class of liquids is illustrated by the forms in (81):

(81) a. ɣwř 'go back' b. Bjs 'wear a belt'

In the absence of an adjacent vowel to the glides in the forms above, their realization as such cannot be explained by reference to the syllable position they occupy; that is, if these glides were underlying high vowels (U, and I respectively) they would surface as u and i. Yet, as can be seen in (81) above, they surface as glides. This suggests that they are underlying glides, a fact that would run counter to the observation that glides and high vowels are in complementary distribution. Due to the complexity of the issue at hand, and because the analysis of segment organization undertaken in chapters IV and V deals with the phonetic level, we will not pursue the analysis of the status of these glides. Instead, we assume that they are underlying segments of ATT (cf. Chap.I, Sect.I.2), and that their sonority index is different from that of high vowels (and their corresponding glides). This index is difficult to determine. Thus, for example, if they are assigned a sonority index of 2, they would result in a syllable configuration which would violate the sonority conditions on the ATT syllable template in (10b) above, as shown by the forms in (82)

(82) θwaɦa 'once'

hwan 'they went down'

According to the intuitions of the native speakers of ATT, these forms are scanned as in (83) below:

(83) θwa.ɦa

hwan

This means that the sequence <u>θw</u> in the first form above and the sequence <u>hw</u> in the second one are members of the onset constituent where they fill the O_2 and the O_1 positions, and as such these sequences will violate the conditions mentioned above. Seeing that the structure of the onset will be taken up in more detail (cf.below), the issue of the sonority index to assign to this class of glides is taken up together with the discussion of resyllabification in a separate section, to which we turn next.

III.4.3 Resyllabification

In the preceding sections dealing with the syllabification rules, it was assumed that the syllabification algorithm assigns each underlying string of segments a syllable representation. After such a representation has been assigned, phonological rules apply, and might result in an a syllable configuration which would violate the sonority conditions on the ATT syllable template in (10b) above, as shown by the forms in (82)

(82) θwaf̂a 'once'

hwan 'they went down'

According to the intuitions of the native speakers of ATT, these forms are scanned as in (83) below:

(83) θwa.f̂a

hwan

This means that the sequence θw in the first form above and the sequence hw in the second one are members of the onset constituent where they fill the O_2 and the O_1 positions, and as such these sequences will violate the conditions mentioned above. Seeing that the structure of the onset will be taken up in more detail (cf.below), the issue of the sonority index to assign to this class of glides is taken up together with the discussion of resyllabification in a separate section, to which we turn next.

III.4.3 Resyllabification

In the preceding sections dealing with the syllabification rules, it was assumed that the syllabification algorithm assigns each underlying string of segments a syllable representation. After such a representation has been assigned, phonological rules apply, and might result in an alteration of syllable trees, or in a change of the relations that hold among consituents of the same syllable. This is especially the case if the domain of the application of syllabification rules exceeds the maximal utterance where no pause can be inserted, which is the one assumed throughout the present work (for a discussion of resyllabification involving junctural phenomena, see Boukous (1987)). The discussion below will center on one major task of resyllabification, namely the building of branching onsets.

The analysis of the syllable structure in the preceding sections did not deal with branching onsets in view of the problematic status of this syllable constituent. To illustrate, here are some forms in (84a) and how they are scanned by our informants in (84b):[13]

(84) a.	θrah	b. θrah	'she went'
	mẑa:n	mẑa:n	'they harvested'

Both forms were reported to be monosyllabic, although in the second form, the sequence <u>mẑ</u> violates the conditions on the sonority of segments to be associated to the O_2 O_1 sequence (cf. 10b above).

Another observation regarding the onset constituent is that it is difficult, if not impossible, to find branching onsets utterance medially (or word medially). (cf. data in chapters IV and V). These two observations about the onset constituent, added to the fact that we did not want to overload the syllabification algorithm of ATT by a rule that would generate branching onsets, are the main reasons for our choice to assign these onsets to resyllabification rules. In other words, we assume that after the application of phonological rules, the syllabification algorithm is set to work again to restore syllable structures in conformity with the sonority conditions on the ATT syllable template, and adjoin a syllable with a null onset and a null R_2 position to the syllable on its right. The branching onsets would be a result of the following convention:

(85) Associate a segment X in the R_1 position of a syllable whose O_1 and R_2 positions are empty to the O_2 node of the syllable on its right if:
(i) $SI(X) \leqslant SI\ O_2$, and
(ii) $SI(X) < 7$.

By the convention in (85) the syllables in (86a) will be fused into one syllable while those in (86b) will not:

(86) a. θ.sa 'liver' b. i.win 'for that one'

The syllable θ in (86a) will be adjoined to the syllable sa to yield the monosyllabic form θsa, which is in conformity with the intuitions of the native speakers of ATT. By contrast, the syllable i in (86b) will not be adjoined to the one on its right since the sonority index of i (underlying I) is equal to that of w (SI(U)=7). It should be pointed out at this stage, that whatever sonority index is assigned to the glides in ATT, forms displaying these segments will violate the sonority condition on the ATT template and the SSG in (1). To illustrate, consider the forms in (87) below:

(87) a. twd.da: 'she gets lost'   b. ɣwin 'they flew'

In the form in (87a) the segment w which occurs in the same syllable as t (in the O_2 position) and d (in the R_1 position) must have a sonority index inferior or equal to that of t (i.e. 1 or 0). In the form in (87b), it must be assigned a sonority index superior or equal to that of ɣ (i.e. 4, 5, 6, or 7), which is not possible since segments are specified by one sonority index.

It becomes clear that the issue of the sonority index of glides in ATT (and in Berber in general) remains a thorny problem to solve.

In the analysis undertaken in chapters IV and V, the glides that will be examined are those classified under a) and b) above (Sect.4.2), i.e. those whose SI=7.

III.4.4. Recalcitrant data

Despite the fact that the proposed syllabification algorithm accounts for a wide range of data from ATT, it cannot syllabify the forms given in (88) below:

(88) ʒðr̂θ 'you (Pl.) repair'

xðmθ 'you(Pl.) work'

fʒr̂θ 'you (Pl.) do'

smr̂θ 'you (Pl.) show'

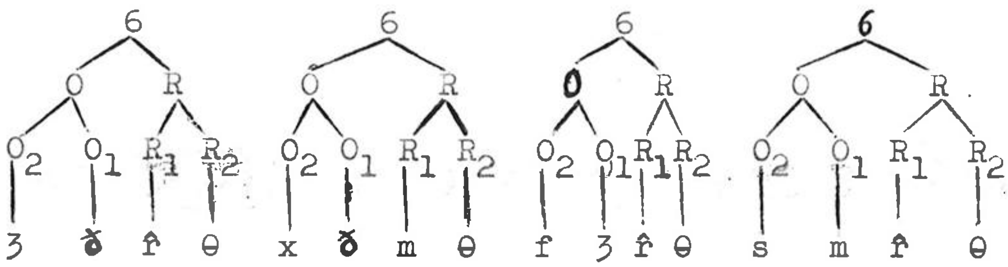
These forms are syllabified by the native speakers of ATT as indicated in (89):

(89) ʒð̌.r̂θ xð̌.mθ fʒ.r̂θ sm.r̂θ

It will be redundant to state that the forms in (89), as syllabified by the native speakers of ATT, cannot be accounted for by the algorithm proposed for ATT, since it will yield the following unacceptable representations:

(90) ʒ.ð̌r̂θ x.ð̌mθ f.ʒr̂θ s.mr̂θ

The application of (85) to the forms above will yield the following monosyllabic forms:



which do not match the intuitions of the native speakers whereby the forms in question are disyllabic as shown in (89) above. Moreover, even without the application of the convention in (85) the forms yielded by the syllabification algorithm will not conform to the intuitions of the ATT native speakers. We conclude, based on the above observation, that these forms are representative of recalcitrant data which await further investigation.

III.5 Conclusion

This chapter dealt with some specific characteristics of the syllable structure of ATT. In particular, it was argued that onsetless syllables are attested post-pausally and utterance-medially. It was also argued that the universally claimed sonority sequencing generalization is only partially true of ATT where the $SI(O_2) \leqslant SI(O_1) \leqslant SI(R_1)$; an observation which suggests the reformulation of the conditions on the syllable template of ATT, so as to accomodate for the above fact.

Having analysed the syllable structure, which serves as the domain for capturing generalisations on segment organization in ATT, we proceed to the investigation of the restrictions that hold on segments co-occurring in the onset constituent (cf. Chap.IV) and the rime constituent (cf. chap.V).

Footnotes to chapter III.

(1) The original title of the convention in question is "Core Syllable Association" (Ito (1986:2). We ~~replace~~ the term'conditon' by 'association' since we interpret this convention as a syllable building rule and not as a conditi dition on syllable (cf. Ito (Ibid) for a detailed account of the templatic approach which is claimed there to be more effective in accounting for syllable-based rules than the rule building approach).

(2) It will become clear below (see Sect.3) that X in the sequence XY can have the same sonority index as Y.

(3) cf. El Medlaoui (1985), Dell and El Medlaoui (1985) for arguments in favour of a rightward directionality, and Boukous (1987) who argues in favour of the leftward strategy.

(4) One of the problems we were faced with is that when the native speakers, consulted for syllable scanning, gave their judgements regarding syllable boundaries, they had to alter their rate of speech from normal (or casual) to slow.

(5) The sonority conditions on this template (cf.10b) are in conformity with the sonority sequencing generalization in (1). It will be argued (cf. sect.4.3 below) that the sequence O_2 O_1 R_1 can have the same sonority indices $(SI(O_2)=SI(O_1)=(SI(R_1)$. The ordering of O_2 before O_1 ...

reflects the observation that there can be no segment in the O_2 position if the O_1 slot is empty (i.e. not associated to a segment from the melody tier) (cf. Selkirk (1984)).

(6) There was disagreement among the informants (native speakers of ATT) as to whether this form is monosyllabic or disyllabic, i.e. qffnt or qf.fnt (where the dot indicates the syllable boundary). (for a discussion of problematic forms including this form, cf. Sect.4.4 below).

(7) This is another way to constrain the syllabification algorithm proposed for ATT from applying to strings of segments across word ~~or phrase boundari~~ es. For a detailed study of phonotactic constraints that hold across such boundaries, cf. Boukous (1987) . We are not in a position to decide on the proper domain for the operation of syllabification rules at the present stage; thus, our choice of the domain of syllabification rules is simply a working solution.

(8) The parenthetical element (Y) indicates that postpausal syllables can be onsetless in Imdlawn Tashlhiyt, which is the variety the authors are dealing with. It will become clear (Sect. 3.2 below) that ATT also allows onsetless syllables post-pausally (and in the middle of the syllabification domain as well). For convenience of analysis, we continue to assume that CS(14) operates on sequences

XY (or YZ in Dell and El Medlaoui's notation) where Y is a segment whose sonority index is superior to X, and where X is any segment.

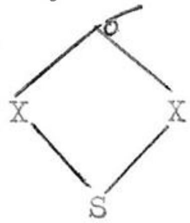
(9) For practical considerations (viz. space and typing constraints) syllables of the type O_1R_1; $O_1R_1R_2$; $O_1R_1R_2R_3$ will be represented as X Y; X Y Z; and X Y Z V respectively.

(10) I am greatly indebted to A.Jebbour who suggested to me the possibility of considering onsetless syllables word internally. However, the way this suggestion is formalized in the present analysis is my sole responsibility.

(11) It should be noted that the forms in (40) will be assigned the correct syllable representation if principle (38) is taken to operate from right to left as is clear from the following illustration. In the form in (40b), for instance, the structural description of rule (38) is met by the sequence zf which will be interpreted as its X Y, and hence z (or X) will be made the nucleus of an onsetless syllable. The segments m and f will be adjoined to the syllables on their left by CA(18).(cf. Sect.3.4 for arguments in support of the leftward directionality (from right to left))

(12) In fact, even the position adopted here solves the problem only partially. Thus, while it can account for the syllable scansions ad.da: 'cliff' im.muθ 'he died' which conform to the intuitions of the native speakers (who

did not accept ȧ.dda or i.mmuθ), it will be faced by the problem of accounting for forms like θtt.sm 'you Pl. slept' and other similar ones. The problem posed by these forms is that the syllabification algorithm of ATT will make of the geminate segments syllables of the form:



syllable terminal positions

melody tier

which are counter intuitive (θ.tt.sm). At the present stage we cannot provide a satisfactory solution for the problem at hand.

(13) Other forms in ATT raise the same problem as the one posed by the form mẑa:n. We will not dwell on this issue here, especially since such sequences which violate the sonority conditions on the ATT template arise mainly in the onset constituent (for a reformulation of the conditions on the ATT syllable template see below)

CHAPTER FOUR

SEGMENT ORGANIZATION IN ATT:
THE ONSET CONSTITUENT

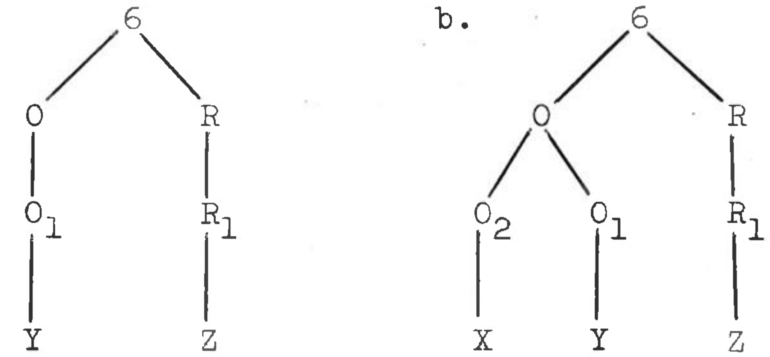
IV.0 Introduction

It was argued in Chapter II. that the proper domain for stating phonotactic constraints is the syllable. The structure of the syllable in ATT was the main concern of Chapter III., where it was argued that the maximal syllable is made up of (i) a branching onset, (ii) an obligatory constituent which is the R_1 position (or the nucleus of the syllable), and (iii)two other positions in the rime, namely R_2 R_3 (or the coda).

The goal of this chapter is to provide answers to questions related to the nature of the onset and the segments that may occur in this constituent. These questions are: (a) what are the segments that can occur in a non-branching onset (i.e., when the O_2 position is empty and only O_1 is associated to a segment from the melody tier)? (b) what are the segments that may occur in the O_2 position when the O_1 node governs any of the segments predicted by the sonority conditions on syllable terminal positions?

Answers to questions (a) and (b) will be given as we analyse the sets of segments co-occurring in syllables of the type in (1a) and (1b), respectively:

(1) a. b.



(where X, Y, and Z $\neq \emptyset$)

The consituents of O_1 (i.e., any segment Y attested in that position) will be examined with Z taking all its possible values, i.e. when SI(Z) $\leqslant$8. For each value of Z, e.g., when SI(Z)=7, all the segments that are predicted by the sonority conditions in (2b) below, to fill the O_1 position (any segment with a SI $\leqslant$7) will be listed under the O_1 node if they are actually attested in that position in ATT; otherwise, proper filters cast in terms of sonority indices and/or place of articulation features (SI indices and PA features, respectively) will be provided to rule out the wrongly predicted segments (cf. ATT template in (2) below).

The second question will be answered in the same way as question (a). That is, the set of segments that are predicted to occur in the O_2 position will be examined with O_1 filled with any segment characterized in the answer to the question in (a). The segments correctly predicted to fill the O_2 position will be listed under the O_2 node, and those that are wrongly predicted by the conditions in (2b) will be ruled out by proper filters.

Throughout the analysis presented in this chapter we will be referring to the segments investigated by their sonority indices (SI) and their place of articulation (PA). Thus, any condition of co-occurrence involving the segment f with other segments, for example, will specify f as having a SI(3) and a PA(10), in order to distinguish it from all the other segments which have a SI(3) (i.e., θ, s, ŝ, x and ħ) on the one hand and from all the other segments which have a PA(10) (i.e., b, B, and m) (cf. Chap. II., Sect.4).

It should be pointed out that the investigation of segment organization undertaken in the present work holds at the phonetic level. This is so because of the abstract nature of underlying representations where it is difficult if not impossible, to elicit the judgements of the native speakers (cf. Marsil (1988) for a similar observation). Thus, the illustrative forms that will be given are surface forms. Moreover, the rate of speech in which these forms are produced by the native speakers of ATT is the slow tempo.

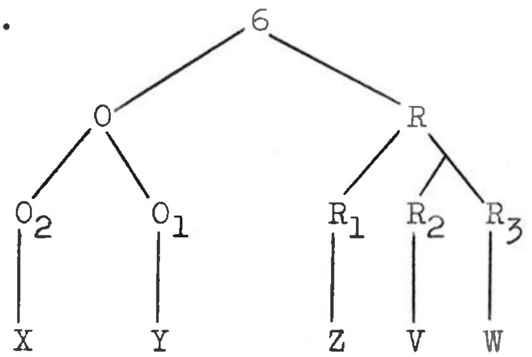
Due to the problematic status of the segments p, ĉ, ĵ, ç, y, kk^w, gg^w and $ŋŋ^w$, they will not be examined in the present and following chapters. (cf. Chap.I.). Similarly, long vowels will not be dealt with. Geminate segments will be represented as sequences of two identical segments utterance-medially and as long segments utterance-finally.

and utterance initially.

In view of the constant reference that will be made to the syllable template of ATT throughout the present and the following chapter, the template in question is reproduced together with the sonority conditions that govern the syllable terminal positions, in (2) below (cf. Chap.III, Sect.2):[1]

(2) <u>The syllable template of ATT</u>

a.



b. $SI(O_2) \ll SI(O_1) \ll SI(R_1) > SI(R_2) > SI(R_3)$

The sonority scale given in (Chap.II., Sect.4) is also reproduced in (3) for ease of reference:

(3)

<u>Segments</u>	<u>Sonority indices</u>
a	8
I, U	7
l, r̂, r	6
m, n	5
B, ð, z, ẑ, ɣ, ʒ, h	4
f, θ, s, ŝ, x, ħ	3
b, d, g	2
t, k, q	1

Finally, the articulatory scale given in (Chap.II., Sect.4) is also reproduced below in (4):

(4) Segments	Place of articulation features
b, B, f, m	10
t, θ, d, ð, n, r̂	9
s, z, l	8
r	7
ŝ, ẑ	6
k, g, i, j, a	5
x, ɣ, u, w	4
q	3
ħ, ʒ	2
h	1

IV.1 Non-branching onsets

The object of the present section is to identify the segments that can occur in the O_1 position when the nucleus of a syllable is filled with a, and the O_2 position is empty (cf.(1a) above).

IV.1.1 The O_1 position with $SI(R_1)=8$

The data in (5) illustrate the co-occurrence of a in the R_1 position with segments predicted by the conditions in (2b) above:to fill the O_1 slot.(the dots indicate syllable boundaries):

(5) SI(O_1)=1: ta.r̂i 'mount Int.' | ik.ka 'he went by' | ir̂.qa 'he met'

SI(O_1)=2: i.ɣb.ba 'he had enough' | θan.da 'pool of water' | θg.ga 'she did'

SI(O_1)=3: fa.fa 'look for' | θa.θa 'camelion' | in.sa 'he spent the night'

ŝa 'something' | xa.sn 'on them' | ħa.ða 'touch'

SI(O_1)=4: Ba.ðu 'edge' | ða 'here' | in.za 'it is ripe'

ẑa: 'between' | ʒa.niθ 'push him' | ɣa.wr̂ 'come here'

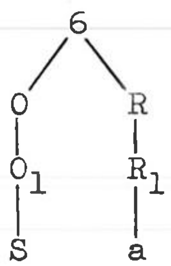
ha:.wð 'step over'

SI(O_1)=5: ma.ni 'where' | ih.na 'he's at peace'

SI(O_1)=6: la.la 'chase' | ma.r̂a 'if' | ra.ħn 'they went'

SI(O_1)=7: ja.ni 'ha had more' | wa.lu 'nothing'

When the R_1 position is occupied by a, whose SI=8, all the segments attested in the O_1 slot have a SI $\leqslant$7. These are listed in (6a), and the condition that captures the fact mentioned above is in (6b):

(6) a. 

b. If SI(R_1)=8 then SI(O_1)$\leqslant$7

S= t, k, q; b, d, g;f, θ, s, ŝ, x, ħ; B, ð, z, ẑ, ɣ, ʒ, h; m, n; l, r̂, r; j, w.

The condition in (6b) above rightly characterizes the segments attested in the non-branching onset of a syllable where a is the nucleus. Thus, there is no need for a filter.

IV.1.2 The O_1 position with $SI(R_1)=7$

The sonority scale in (4) above displays two segments with a SI=7. These are the high vocoids I, and U, which are realized as i and u, respectively, when governed by the R_1 node (cf. Chap.III, Sect.4.2).

a) R_1=i

ATT forms such as those in (7) indicate that when i is in the R_1 position, any segment with a SI≤7 can occur in the slot dominated by O_1:

(7) $SI(O_1)=1$:	a.ti.r̂i 'it will be'	ki.ði 'with me'	a.qi.ðun 'tent'
$SI(O_1)=2$:	zum.bi 'corn'	in.di 'he trapped'	ig.git 'he did it'
$SI(O_1)=3$:	fi.r̂u 'thread'	θi.ni 'dates'	si.ni 'cinema'
	θiŝ.ŝiθ 'louse'	xi.ðu.ra: 'on mountains'	ir̂.ħim 'move away'
$SI(O_1)=4$:	Bi.Bi 'turkey'	ði.ni 'there'	i.zi 'fly'
	i.ẑi.man 'big neck'	r̂u.ʒi 'pus'	a.ɣi 'butter milk'
	a.hi.mur̂ 'a crowd'		
$SI(O_1)=5$:	mi.r̂us 'mud'	i.ni 'say'	
$SI(O_1)=6$:	ʒa.li 'person's name'	a.r̂i.r̂i 'laurel tree'	i.ri 'neck'

<u>$SI(O_1)=7$</u>: i.na.ji 'tell me'   wi.ða 'who's here'

The segments attested in the O_1 position when <u>i</u> is in the R_1 slot are the same as those attested in the O_1 position when <u>a</u> is in the R_1 position: i.e. those listed in (6a). The condition that defines the range of sonority indices of these segments when <u>i</u> is in the R_1 position is given in (8) below:

(8) If $SI(R_1)=7$, and $PA(R_1)=5$
then $SI(O_1) \leqslant 7$

b) <u>$R_1=u$</u>

The data in (9) indicate that the same set of segments attested in the O_1 position when either <u>i</u> or <u>a</u> is in the R_1 slot is also attested in the O_1 slot when <u>u</u> is in the R_1 position:

(9)<u>$SI(O_1)=1$</u>: tu.dum 'it is leaking'   uk.ku 'straw'   a.qu.ðað 'short'

<u>$SI(O_1)=2$</u>: ja:b.bu 'he backs'   in.du 'he jumped'   ig.guẑ 'he moved'

<u>$SI(O_1)=3$</u>: a.fu.nas 'bull'   o:.θu 'fig tree'   su 'drink'

θi.ŝu.maj 'straw baskets'   a:.xu 'release'   a.ħu.f̂i 'male goat'

<u>$SI(O_1)=4$</u>: Bu.nif 'spider'   Ba.ðu 'edge'   a:.zu 'look for'

i.ẑuf̂ 'he travelled'   i.ʒu.ra: 'backs'   a.ɣu.fi 'asthma'

a.ma:.hun 'easy-going person'

$SI(O_1)=5$	mun 'go with'	i.nu 'it is mine'	
$SI(O_1)=6$	wa.lu 'nothing'	r̂um 'straw'	ruθ 'cry, you Pl.'
$SI(O_1)=7$	ju.r̂i 'he climbed'	i.wu.ðay 'for the jew'	

The condition in (10) below captures the fact that all segments with a SI $\leqslant 7$ are attested in the O_1 position when u is dominated by R_1:

(10) If $SI(R_1)=7$, and $PA(R_1)=4$
then $SI(O_1) \leqslant 7$

A comparison between the conditions in (6b), (8) and (10) reveals that they can be expressed by one general condition: It is given in (11):

(11) If $SI(R_1) \geqslant 7$
then $SI(O_1) \leqslant 7$

The conditions in (8) and (10) state that the segments attested in the O_1 position when i or u is in the R_1 position range from glides (j and w) to voiceless stops. That is, the dissimilatory index between the two positions in question is 0.

IV.1.3 The O_1 position with $SI(R_1)=6$

The set of segments whose SI=6 is made up of the liquids l, r̂, and r. Below, we examine the co-occurrence of these segments in the R_1 slot with other segments in the O_1 position.

a) R_1=l

The relevant data for stating the co-occurrence of l with other segments whose SI ≤ 6 are given in (12):[2]

(12) $SI(O_1)=1$:	tl.lf 'lose'	kl.lf 'engage So.'	i.ql.la.wn 'testicles'
$SI(O_1)=2$:	ħb.bl.lh.ta 'type of plant'	°dl	a.gl.las 'seat'
$SI(O_1)=3$:	fl.ls 'to be a failure'	°θl	sl.lam 'person's name'
	°ŝl	xl.lif 'on a lover'	ħl.ls 'convince'
$SI(O_1)=4$:	Bl.lʒ 'close'	ɣl.lif 'it is the lover'	a.zl.lal 'person courting women'
	°ẑl	ʒl.lal 'person's name'	°ɣl
	hl.ll 'praise God'		
$SI(O_1)=5$:	ml.ls 'to cement'	nl.laj.mun 'of lemons'	
$SI(O_1)=6$:	°ll	°r̂l	°rl

The scarcity of forms with l as the nucleus is a result of the phonological processes undergone by this liquid (cf. Chap.I, Sect.1.3). This is why all l's in the data above are first elements of a geminate ll.[6] The segments attested in the O_1 position when l is governed by the R_1 node are given in (13a), and the condition that specifies the sonority indices of these segments is given in

(13b):

(13) a.

$$
\begin{array}{ccc}
 & 6 & \\
 / & & \backslash \\
O & & R \\
| & & | \\
O_1 & & R_1 \\
| & & | \\
S & & l
\end{array}
$$

b. If $SI(R_1)=6$, and $PA(R_1)=8$ then $SI(O_1) \leqslant 5$

S= t, k, q; f, s, ħ; B, z, ʒ, h; m, n.

The condition in (13b) fails to exclude the unattested segments in the O_1 position. This is why the filter in (14) is necessary, since it rules out those segments whose SI $\leqslant 5$ which do not occur in the O_1 position when l̲ is in the R_1 slot:[3]

(14)

$$
\begin{array}{cc}
{}^{\circ}O_1 & R_1 \\
| & | \\
\left\{\begin{bmatrix} SI & PA \\ [4>n>1] & [9] \\ [\;-\;] & [6] \\ [4] & [4] \end{bmatrix}\right\} & \begin{bmatrix} SI & PA \\ [6] & [8] \end{bmatrix}
\end{array}
$$

The filter in (14) excludes the following unattested O_1 R_1 sequences: °d̲l̲, °θ̲l̲, °ŝ̲l̲, °ẑ̲l̲, and °ɣ̲l̲.

b) $\underline{R_1=\hat{r}}$

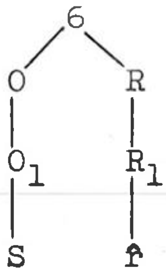
The data in (15) below exemplify the co-occurrence of r̲̂ as R_1 with other segments in the O_1 position:

(15)

<u>SI(O_1)=1:</u>	a.tf̂.qf 'she'll hit'	a:k.kf̂ 'kick Int!'	qf̂.Biθ 'turn it over'
<u>SI(O_1)=2:</u>	ja:b.bf̂ 'he's back-biting	ja:d.df̂ 'he's destroying	iʒ.gf̂ 'it knelt down'
<u>SI(O_1)=3:</u>	θf̂.qf 'she hit'	xf̂.qn 'they're born'	ħf̂.wθ 'drink you, Pl.'
	a.ŝf̂.qix 'I'll meet you'	sf̂.fas 'caress it'	f̂.ff̂.ff̂ 'paprika'
<u>SI(O_1)=4:</u>	qa.Bf̂ 'guard'	ð̌f̂ 'cover'	zf̂.ziθ 'shake it/him'
	θuẑ.ẑf̂ 'she's a widow'	ʒf̂.mas 'warn him'	Ba:.ɣf̂ 'crow'
	hf̂.ŝn 'they're ill'		
<u>SI(O_1)=5:</u>	mf̂.ŝn 'they're mar-ried'	nf̂.mð̌ 'we learnt'	

The data tabulated in (15) above show that all the segments whose SI $\leqslant$5 are attested in the O_1 position when <u>f̂</u> is dominated by R_1. These segments are listed in (16a), and the condition that applies to them is in (16b):

(16) a.



b. If SI(R_1)=6, and PA(R_1)=9 then SI(O_1) $\leqslant$5

S= t, k, q; b, d, g; f, θ, s, ŝ, x, ħ; B, ð̌, z, ẑ, ɣ, ʒ, h; m, n.

c) $\underline{R_1=r}$

The liquid r̲ is not attested in the R_1 position in ATT except as the second element of the geminate r̲r̲, where it functions as an onsetless syllable (cf.V.2.3). This means that r̲ co-occurs with no other segments in the R_2 slot. This generalization can be formalized as in the condition in (17a), and the general condition on the sonority indices of segments attested in the O_1 position is given in (17b):

(17) a. If R_1=r
then O_1= Ø

b. If SI(R_1)=6
then SI(R_2) ≤5

The minimum sonority difference between the O_1 slot and the R_1 position when the latter is filled with a liquid (l̲ or r̲̂) is 1.

IV.1.4 The O_1 position with SI(R_1)=5

The class of segments whose SI=5 is made up of the nasals m̲ and ṁ̲. The sonority conditions on the ATT template in (2b) predict that when either of these nasals is in the R_1 position, the segments that can occur in the O_1 position are those whose SI ≤5. Below, we examine the co-occurrence restrictions that hold on the O_1 R_1 sequences when m̲ or n̲ is in the R_1 slot.

a) <u>R_1=m</u>

The data in (18) exemplify the segments that are attested in the O_1 position of a non-branching onset, when <u>m</u> is under R_1:

(18)	<u>SI(O_1)=1:</u>	tm.se: 'it happens'	km.mf̂ 'finish'	qm.ma: 'gamble'
	<u>SI(O_1)=2:</u>	θs.ħib.bm 'you preferred'	sd.dm 'with blood'	a.g̣ṃ.ṃiẓ 'big cheek'
	<u>SI(O_1)=3:</u>	a.ta.fm 'you'll find'	θm.ɣa: 'she's old'	ṛạ.ħm 'go you Pl.'
		i.ŝm 'for you Fem.'	at.sf̂.xm 'you'll skin'	sm.f̂as 'show him'
	<u>SI(O_1)=4:</u>	°Bm	u.ð̌m 'face'	ij.zm 'he's hurt'
		ẑm.ʒn 'they gathered'	in.ʒm 'he confessed'	a.tn.ɣm you'll kill'
		if.hm 'he understood'		
	<u>SI(O_1)=5:</u>	xð̌.mm 'work you Pl.'	nm.sħ 'we wiped'	

The segments attested in the O_1 position when <u>m</u> is in the R_1 slot are provided in (19a), and the condition on the sonority indices of these segments is given in (19b):

(19) a.

$$\begin{array}{ccc} & \sigma & \\ O & & R \\ | & & | \\ O_1 & & R_1 \\ | & & | \\ S & & m \end{array}$$

b. If $SI(R_1)=5$, and $PA(R_1)=10$ then $SI(O_1) \leqslant 5$

S= t, k, q; b; d; g; f, θ, s, ŝ, x, ħ; ð, z, ẑ, ɣ, ʒ, h; m, n.

The condition in (19b) generates the attested segments in the O_1 position which are listed in (19a) as well as the unattested syllable <u>Bm</u>. This syllable is ruled out by the filter in (20) below:

(20) $$^{\circ}\begin{matrix} O_1 \\ \left[\begin{matrix}[4] & [10]\end{matrix}\right] \end{matrix} \qquad \begin{matrix} R_1 \\ \left[\begin{matrix}[5] & [10]\end{matrix}\right] \end{matrix}$$

b) <u>R_1=n</u>

The segments attested in the O_1 position when the dental nasal <u>n</u> is in the R_1 slot are illustrated by the data in (21):

(21)	<u>$SI(O_1)=1$:</u>	a.tn.dh 'she'll drive'	kn.niw 'you Pl.'	xr̂.qn 'they're born'
	<u>$SI(O_1)=2$:</u>	sb.bn 'wash'	Bd.dn 'they stood'	a.tg.gn 'they'll do it'
	<u>$SI(O_1)=3$:</u>	θn.ja 'she climbed'	fn.nix 'I'm suffering'	sn.du 'churn milk'
		ŝn.ŝr̂ 'shake'	xn.sn 'they avoided'	ri.ħn 'they stink'

<u>$SI(O_1)=4$:</u>	ɣa.Bn 'they're absent'	e:.ð̌n 'wheat'	zn.ziθ 'sell it'
	iẑ.ẑn ''one'	ið̌.ʒn 'he resigned'	uz.ɣn 'they're dry'
	nd.hn 'they drove'		
<u>$SI(O_1)=5$:</u>	a.mn 'believe'	tmu.nn 'they go with'	

The segments attested in the O_1 position when <u>n</u> is dominated by R_1 are those given in (19a) above, together with the labial <u>B</u>. The condition that captures this fact is formalized in (22):

(22) If $SI(R_1)=5$, and $PA(R_1)=9$
then $SI(O_1) \leqslant 5$

The condition in (23) below is a generalized version of conditions (19a) and (22):

(23) If $SI(R_1)=5$
then $SI(O_1) \leqslant 5$

The addition of the filter in (20) above remains necessary to rule out the unattested syllable <u>°Bm</u>.

The sonority difference between O_1 and R_1 positions when $SI(R_1)=5$ is 0. This means that the segments attested in the O_1 position range from nasals to voiceless stops.

IV.1.5 <u>The O_1 position with $SI(R_1)=4$</u>

The class of segments whose SI=4 is made up of the following voiced fricatives: <u>B</u>, <u>ð̌</u>, <u>z</u>, <u>ẑ</u>, <u>ɣ</u>, <u>ʒ</u>, and <u>h</u>. We examine below the possibilities of their co-occurrence with other segments.

a) R_1=B

The segments attested in a non-branching onset when B is in the R_1 position are illustrated by the data in (24):

(24) $SI(O_1)=1$:	tB.ʒiθ 'follow him	ja:k.kB 'he fixed'	iʒ.qB 'he returned'
$SI(O_1)=2$:	°bB	iʒd.dB 'he suffered'	ja:.gB 'he went out of sight'
$SI(O_1)=3$:	°fB	θB.na 'she built'	iħ.sB 'he counted'
	ja:.ŝB 'he fixed'	xB.ŝiθ 'scratch him'	ja:ħ.ħB 'he welcomed'
$SI(O_1)=4$:	°BB	Bð̌.ʒit 'start it'	i.qz.zB 'he dressed up'
	ẑB.ð̌it 'pull it'	ʒB.ð̌n 'they wor-shipped'	ɣB.niθ 'deprive him of Sth.'
	i.wh.hB 'he devoted'		

With the exception of the labials b, f, and B, all segments with a SI $\leq$ 4 can occur in the O_1 position when B is in the R_1 slot; these are listed in (25a), and the condition specifying their sonority indices is given in (25b):

(25) a.

```
        6
      /   \
     O     R
     |     |
     O1    R1
     |     |
     S     B
```

b. If $SI(R_1)=4$, and $PA(R_1)=10$ then $SI(O_1) \leqslant 4$

S= t, k, q; d, g; θ, s, ŝ, x, ħ; ð, z, ẑ, ɣ, ʒ, h.

Since the condition in (25b) above does not rule out the unattested syllables °<u>bB</u>, °<u>fB</u>, °<u>BB</u>, there is need for a filter to exclude them. This filter is formalized in (26):

(26) $$^{\circ}\Big[[-]\;\overset{O_1}{|}\;[10]\Big]\Big[[4\;\overset{R_1}{|}\;[10]\Big]$$

b) <u>R1=ð</u>

ATT forms such as those in (27) indicate that when R_1=0, all segments with a SI $\leqslant 4$ are attested in the O_1 position:

(27) <u>$SI(O_1)=1$:</u>	tð.waf̂ 'go back'	wi.kð 'with whom'	θfaq.qð 'you're awake'
<u>$SI(O_1)=2$:</u>	id.dð 'he sweated'	ʒb.bð 'worship'	a.gð 'with'
<u>$SI(O_1)=3$:</u>	a.ta.fð 'you'll find'	θð.wf̂ 'she went back'	sð.rus 'with a little'
	at.mf̂.ŝð 'you'll marry'	xð.mn 'they worked'	a.ta.ħð 'you'll go'

8

SI(O_1)=4:	Bǒ.ʒit 'start it'	θgg^w.ǒǒ 'you're afraid'	θça:.zǒ 'you ploughed'
	iw.ẑǒ 'he's ready'	ʒo.f̂iθ 'repair it'	i.ma:.ɣǒ 'dust'
	at.nd.hǒ 'you'll drive'		

The attested segments in the non-branching onset with ǒ in the R_1 position are those listed in (25a) and the labials b, f, and B. That is, all the segments whose SI≤4 can occur in the O_1 position. This generalization is captured by the condition in ((28) below:

(28) If SI(R_1)=4, and PA(R_1)=9
then SI(O_1) ≤4

c) R_1=z

The data in (29) illustrate the set of segments that are attested in the O_1 position when z is in the R_1 slot:

(29) SI(O_1)=1:	tz.wiɣ 'it becomes red'	iʒ.ʒuk.kz 'he walked with a cane'	qz.qu.za 'a type of insect'
SI(O_1)=2:	i.hn.dz 'he planned'	iq.bub.bz 'he's fat'	iʒ.gz 'he's lazy'
SI(O_1)=3:	i.fz 'chewing'	θz.f̂i 'she twisted'	sz.wa 'cause to cross'
	a.ŝz.zn.zx 'I'll sell you'	xz.niθ 'cover it'	ħz.nn 'they're sad'
SI(O_1)=4:	Bz.zaf 'too mush'	i.ǒz 'hitting'	Bz.zz 'compulsory'
	°ẑz	ʒz.f̂n 'they split'	i.ɣz.ran 'rivers'
	i.hz.miθ 'he defeated him'		

The segments attested in the O_1 position when ẑ is under R_1 are those listed in (25a) with the exception of ẑ, and the labials: b, f, and B, which means that these segments have a SI $\leq$ 4. This fact is captured by the condition in (30) below:

(30) If SI(R_1)=4, and PA(R_1)=8
then SI(O_1) $\leq$ 4

The condition above wrongly predicts the unattested syllable °ẑz. The filter provided in (31) below has the effect of excluding this syllable from the set of attested ones:

(31) $$^{\circ}\begin{array}{c} O_1 \\ | \\ \begin{bmatrix}[4] & [6]\end{bmatrix}\end{array} \qquad \begin{array}{c} R_1 \\ | \\ \begin{bmatrix}[4] & [8]\end{bmatrix}\end{array}$$

d) R₁=ẑ

The segments that are attested in the O_1 position when ẑ is dominated by R_1 are illustrated by the data below:

(32) SI(O_1)=1:	a.tẑ.m3 'she'll gather'	°kẑ	a.Ba:.qẑ.ẑiẑ 'cricket'
SI(O_1)=2:	ja:b.bẑ 'he made a mess'	a.dẑ.nn 'they'll lie down'	i.gẑ.ẑa 'that he left
SI(O_1)=3:	fẑ.ẑa: 'get up early'	θẑ.Bǒ 'she pulled'	sẑ.ra 'cause to happen'
	°ŝẑ	xẑ.ẑu3 'on hunger'	ħẑ.Bnt 'they're veiled'

SI(O_1)=4: da:.Bẑ 'make untidy' a.ðẑ.ẑn 'they'll let' °zẑ

°ẑẑ 3ẑ.niθ 'step over it' it.ɣẑ.ɣuẑ 'it's creaking'

hẑ.mn 'they attacked'

The sonority index of the segments that occur in the O_1 position when ẑ is in the R_1 slot is inferior or equal to 4. These segments are given in (33a), and the condition on their sonority indices is expressed by (33b):

(33) a.

```
      6
     / \
    O   R
    |   |
    O1  R1
    |   |
    S   ẑ
```

b. If SI(R_1)=4, and PA(R_1)=6, then SI(O_1) $\leqslant$ 4

S= t, q;b, d, g;f, θ, s, x, h; B, ð, ɣ, 3, h.

The condition in (33b) generates the attested nuclear syllables as well as the unattested ones: °kẑ, °ŝẑ, °zẑ, and °ẑẑ. The filter given in (34) rules out these sequences:

(34)
$$^{\circ}\left\{\begin{array}{l}\left[[-] \overset{O_1}{|} [6]\right] \\ \left[[4] \quad [8]\right] \\ \left[[1] \quad [5]\right]\end{array}\right\} \left[[4] \overset{R_1}{|} [6]\right]$$

e) R_1=3

The co-occurrence of 3 in the R_1 position with other segments in the O_1 slot is illustrated in (35):

(35) <u>SI(O_1)=1:</u>	tʒ.naj 'she's my relative'	a.kʒ.Bo: 'hunch-back'	i.Ba:.qʒ 'hit So. on th the head'
<u>SI(O_1)=2:</u>	ja:b.bʒ 'he sat down'	a.dʒ.ðan 'they'll come by'	a.gʒ.ro: 'a hill'
<u>SI(O_1)=3:</u>	fʒ.r̂n 'they did'	θʒ.ma 'she's blind'	sʒ.ða 'make do'
	a.ŝʒ.kuk 'hair'	xʒ.r̂i 'on Ali'	°ħʒ
<u>SI(O_1)=4:</u>	ðʒ.nn 'they re-signed'	ra.Bʒ 'run'	zʒ.mn 'they dared'
	a.ẑʒ.Bo: 'buttocks'	°ʒʒ	°ɣʒ °hʒ

The segments that are attested in the O_1 position when <u>ʒ</u> is in the R_1 slot are those whose SI $\leqslant$4, with the exception of the velar ɣ, the pharyngeals <u>ħ</u>, <u>ʒ</u>, and the laryngeal <u>h</u>. The condition on the sonority indices of the attested segments is given in (35):

(35) If SI(R_1)=4, and PA(R_1)=2
then SI(O_1) $\leqslant$4

The filter excluding the unattested syllables where <u>ʒ</u> is in the R_1 position is provided in (36) below:

(36)
$$\left\{\begin{array}{l} \overset{°O_1}{\left[[-\ \ [<3]\right]} \\ \left[[4]\ \ [4]\right] \end{array}\right\} \quad \overset{R_1}{\left[[4]\ \ [2]\right]}$$

The exclusion of the segments <u>ħ</u>, <u>ɣ</u>, <u>ʒ</u>, and h from the O_1 position of a syllable whose nucleus is <u>ʒ</u> might be explained by referring to their place of articulation. They are articulated in the back region of the vocal tract, and, as such, they cannot co-occur with the pharyngeal ʒ.

f) R_1 = ɣ

The forms in (37) illustrate the segments attested in the O_1 position when ɣ is in the R_1 slot:

(37) $SI(O_1)=1$:	a.tɣ.zm 'you'll dig'	ta:.kɣ.ɣas 'I let him'	ɣa:.qɣ.ɣas 'I drownded for him'
$SI(O_1)=2$:	sħib.bɣas 'I wanted for him'	a.dɣ.zn 'they'll dig here'	ma.xa:.gɣ.ɣas 'I didn't understand him'
$SI(O_1)=3$:	if.fɣ 'he went out'	θɣ.ð̂f 'she dropped'	sɣ.mi 'cause to grow'
	ŝɣ.f̂n 'they're busy'	na.xɣ.ɣas 'I starved for him'	ra.ħɣ.ɣas 'I went for him'
$SI(O_1)=4$:	Bɣ.dad 'person's name'	ð̂ɣ.ja 'be quick'	a.zɣ 'dry up'
	ẑɣ.did 'wine''	if̂.ɣɣ 'it is soft'	qð̂.ʒɣ.ɣas 'I forbade him'
	ŝa:.hɣ.ɣas 'I hate for him'		

The segments attested in the O_1 position when ɣ is in the R_1 slot are those whose SI ≤ 4 (cf. (3) above). This is expressed by the condition in ((38):

(38) If $SI(R_1)=4$, and $PA(R_1)=4$

then $SI(O_1) \leqslant 4$

g) R_1=h

The set of segments that are attested in the O_1 position when h is under R_1 are illustrated by (39):

(39) $SI(O_1)=1$:	a.th.wa 'she'll go down'	°kh	ðif̂.qh.wa 'in the coffee'
$SI(O_1)=2$:	nb.bh 'warn'	a.dh.wan 'they'll come down'	u[illegible]gh.wan 'who went down'
$SI(O_1)=3$:	fh.mn 'they understood'	θh.na 'she's at peace'	sh.wn 'cause to be easy'
	ŝh.ra.jn 'two months'	xh.la.li.ja 'on Hlalija'	°ħh
$SI(O_1)=4$:	Bh.df̂ 'humiliate'	a.ðh.wan 'they'll go down'	a.zh.wani 'joyful man'
	ẑh.ðn 'they are strong'	°ɣh	°ʒh, °hh

The data in (39) above clearly indicate that the segments attested in the O_1 position of a syllable where R_1 is occupied by h have a SI $\leqslant 4$, which is stated by the condition in (40) below:

(40) If $SI(R_1)=4$, and $PA(R_1)=1$
then $SI(O_1) \leqslant 4$

Since the condition in (40) wrongly predicts the syllables °kh, °ħh, °ɣh, °ʒh, and °hh, their exclusion is effected by the filter in (41)

(41)

$$\begin{array}{c} \quad O_1 \\ \left\{\begin{array}{l} \left[[-] \qquad [<3]\right] \\ \left[[4] \qquad\ [4]\right] \\ \left[[1] \qquad\ [5]\right] \end{array}\right\} \end{array} \qquad \begin{array}{c} R_1 \\ \left[[4] \qquad [1]\right] \end{array}$$

Based on the data presented throughout the discussion above of O_1R_1 syllables -where R_1 dominates a voiced fricative- it becomes clear that the segments attested in the O_1 position have a SI $\leqslant 4$. This generalization makes it possible to collapse conditions (26b), (28), (30), (33b), (35), (38), and (40) into one general condition:

(42) If $SI(R_1)=4$
then $SI(O_1) \leqslant 4$

The condition in (42) above shows that the dissimilarity index between the O_1 and the R_1 slots, where R_1 dominates a voiced fricative, is 0. That is, segments whose sonority indices range from 4 to 1 are attested in the O_1 position. The general condition above must, of course, be supplemented by all the filters formalized in the present section (IV.1.5).

The discussion above shows that the labial $\underline{B}$, the palato-alveolar $\underline{\hat{z}}$, and the laryngeal $\underline{h}$ -when in the R_1 position- are the segments which do not co-occur with other segments articulated in the same region as them. Thus, it was shown that the labial $\underline{B}$ does not co-occur with the labials $\underline{b}$, $\underline{f}$, and $\underline{B}$ (cf. Filter (26) above); the palato-alveolar $\underline{\hat{z}}$ does not co-occur with the alveolar $\underline{z}$, the palato-alveolars $\hat{s}$ and $\underline{\hat{z}}$, and the velar $\underline{k}$ (cf. Filter (34) above); the pharyngeal

pharyngeal <u>ʒ</u> does not co-occur with the velar <u>ɣ</u>, the pharyngeals <u>ħ</u> and <u>ʒ</u>, and the laryngeal <u>h</u> (cf. Filter (36) above). Finally, the laryngeal <u>h</u> does not co-occur with the velars <u>k</u> and <u>ɣ</u>, the pharyngeals <u>ħ</u> and <u>ʒ</u>, and the laryngeal <u>h</u>.

By contrast, the dental <u>ð̂</u> co-occurs with segments whose SI $\leqslant 4$ regardless of their place of articulation. Such is the case with the alveolar <u>z</u> which co-occurs with any segment with a SI $\leqslant 4$, except for the palato-alveolar <u>ẑ</u>, and the velar <u>ɣ</u> which co-occurs with segments articulated in different parts of the vocal tract, including the velars <u>k</u>, and <u>ɣ</u>.

IV.1.6 <u>The O_1 position with SI(R_1)=3</u>

The set of voiceless fricatives that can function as syllable nuclei is: <u>f</u>, <u>θ</u>, <u>s</u>, <u>ŝ</u>, <u>x</u>, and <u>ħ</u>. Below, we examine the conditions of co-occurrence of each element of this set with all segments that have a SI $\leqslant 3$.

a) <u>R_1=f</u>

The data in (43) illustrate the segments attested in the O_1 position when <u>f</u> is in the R_1 slot:

(43)	<u>SI(O_1)=1:</u>	a.tf.na 'she'll be exhausted'	f̂.kf.ta 'minced meat'	qf.f̂iθ 'close it'
	<u>SI(O_1)=2:</u>	°bf	a.df.ro:.jn 'they'll be hatched'	a.gf.f̂an 'with a certain person'

<u>SI(O_1)=3:</u>	°ff	θf.hm 'she under-stood'	su.sf 'spit'
	a.ŝf.fa: 'thief'	min.xf 'what for'	ħf.ðn 'they learnt'

As can be seen from the data above, all segments with a SI $\leqslant 3$ are attested in the O_1 position except the labials <u>b</u> and <u>f</u>. This is why the list in (44a) does not include <u>b</u> and <u>f</u>, although they are predicted by the condition in (44b):

(44) a.

```
      6
     / \
    O   R
    |   |
    O1  R1
    |   |
    S   f
```

b. If SI(R_1)=3, and PA(R_1)=10 then SI(O_1) $\leqslant 3$.

S = t, k, q; d, g; θ, s, ŝ, x, ħ.

The filter in (45) below excludes the unattested syllables °<u>bf</u> and °<u>ff</u>:

(45) $$\left[[-] \overset{°O_1}{|} [10] \right] \quad \left[[3] \overset{R_1}{|} [10] \right]$$

It is not necessary to specify the sonority indices of the excluded segments, since this is done by the condition in (44b).

b) <u>R_1=θ</u>

The ATT forms given in (46) show that any segment whose SI $\leqslant 3$ can occur in the O_1 position when <u>θ</u> is in the R_1 slot:

(46) <u>$SI(O_1)=1$:</u>	tΘ.me: 'it is getting fat'	tk.km 'you go by Pl.'	a.qΘ 'here it is'
<u>$SI(O_1)=2$:</u>	sḥib.bΘ 'prefer Pl.'	Bd.dΘ 'stand up'	wa.tg.gΘ 'don't do Pl.'
<u>$SI(O_1)=3$:</u>	fΘ.f̂Θ 'roll cous-cous Pl.'	sΘ.fawt 'with light'	wa:.ΘΘ 'you inherit Pl.'
	mf̂.ŝΘ 'marry Pl.'	xΘ.ma 'on the edge'	ra.ḥΘ 'go you Pl.'

The segments attested in the O_1 position when <u>Θ</u> is governed by the R_1 node are those given in (44a) above together with the labials <u>b</u> and <u>f</u>, i.e., all segments whose SI $\leqslant 3$. This generalization is captured by the condition in (47) below:

(47) If $SI(R_1)=3$, and $PA(R_1)=9$

the $SI(O_1) \leqslant 3$

c) <u>$R_1=s$</u>

The data in (48) below illustrate the co-occurrence of <u>s</u> in the R_1 position with other segments in the O_1 slot:

(48) <u>$SI(O_1)=1$:</u>	ts.f̂a 'she hears'	i.ks.BiΘ 'he owns it'	qs.siΘ 'cut it'
<u>$SI(O_1)=2$:</u>	i.ḥb.bs 'he's imprisoned'	ah.ds 'let it'	a.gs.f̂i.man 'with Slimane'
<u>$SI(O_1)=3$:</u>	Θs.wa 'she drank'	fs.jiΘ 'untie it'	i.ss: 'he's drinking'
	a.ŝs.f̂m.δx 'I'll teach you'	i.xs.si 'it is turning off'	ḥs.Bn 'they counted'

What is said above of syllables O_1 R_1 where R_1 governs <u>ө</u> also applies to syllables O_1 R_1 where R_1 dominates <u>s</u>. That is, all segments whose SI $\leqslant 3$ are attested in the O_1 position when <u>s</u> is in the R_1 position. This generalization is captured by the condition in (49) below:

(49) If $SI(R_1)=3$, and $PA(R_1)=8$
 then $SI(O_1) \leqslant 3$

d) <u>R_1=ŝ</u>

The segments that occur in the O_1 slot when R_1 dominates <u>ŝ</u> are illustrated by the data in (50):

(50)	<u>$SI(O_1)=1$:</u>	a.tŝ.ŝð 'you'll eat'	a.kŝ.ŝuð 'stick'	a.qŝ.Baf̂ 'bad face'
	<u>$SI(O_1)=2$:</u>	ʒb.bŝ 'press down'	a.dŝ.θin 'they'll take here'	xa:.gŝ 'do nonsense'
	<u>$SI(O_1)=3$:</u>	fŝ.f̂n 'they're exhausted'	θŝ.ram 'you Pl rented	sŝ.θu 'couscous'
		i.ħŝ.ŝŝ 'he's drugged'	xŝ.ha: 'on a month'	ħŝ.ŝn 'they played a joke'

The data in (52) above indicate that the segments attested in the O_1 position when <u>ŝ</u> is in the R_1 slot are the same as those attested in the O_1 position when <u>ө</u> or <u>s</u> is in the R_1 position, i.e. segments whose SI $\leqslant 3$. This is expressed by the condition in (51) below:

(51) If $SI(R_1)=3$, and $PA(R_1)=6$
 the $SI(O_1) \leqslant 3$

e) $\underline{R_1 = x}$

The data in (52) illustrate the set of segments which are attested in the O_1 position when x is under R_1:

(52) $SI(O_1)=1$:	a.tx.ɣm 'she'll work'	a.ɣk.kx 'I'll go by'	ɣf.qx 'I released'
$SI(O_1)=2$:	qd.dx 'I'm able'	ḥib.bx 'I loved'	a.ɣg.gx 'I'll do'
$SI(O_1)=3$:	f̂q.fx 'I hit'	θx.sm 'You Pl. want'	sx.si 'turn off'
	hf̂.ŝx 'I'm ill'	na.xx 'I starve'	fu.ḥx 'I smell good'

The voiceless fricative x behaves in the same manner as θ, s, and ŝ, since it co-occurs with any segment whose $SI \leqslant 3$. The condition in (53) below captures this fact:

(53) If $SI(R_1)=3$, and $PA(R_1)=4$

then $SI(O_1) \leqslant 3$

f) $\underline{R_1 = ḥ}$

The co-occurrence of ḥ in the R_1 position with other segments in the O_1 position is illustrated by the forms in (54) below:

(54) $SI(O_1)=1$:	tḥ.saB 'count Int.'	kḥ.ḥf̂ 'put on khool'	if̂.qḥ 'it bloomed'
$SI(O_1)=2$:	a.dḥ.ɣan 'they'll come'	ja:ḥ.bḥ 'he gains'	in.gḥ 'he elbowed'

$SI(O_1)=3$	ka.fħ 'militate'	θħ.sB 'she counted'	iq.sħ 'it is difficult'
	a:ŝ.ŝħ 'be a candidate for'	xħ.ma.ma 'on Hmama'	°ħħ

The segments that occur in the O_1 slot when R_1 dominates the pharyngeal ħ are those whose SI $\leqslant 3$, with the exception of ħ. These segments are predicted by the condition in (55):

(55) If $SI(R_1)=3$, and $PA(R_1)=2$
then $SI(O_1) \leqslant 3$

The unattested syllable °ħħ is ruled out by the filter given in (56) below:

(56) $$\left[[3] \overset{{}^{\circ}O_1}{|} [2]\right] \left[[3] \overset{R_1}{|} [2]\right]$$

The conditions given in (44b), (47), (49), (51), (53), and (55) can be collapsed into one general condition:

(57) If $SI(R_1)=3$
the $SI(O_1) \leqslant 3$

The syllables O_1 R_1 -where R_1 dominates a voiceless fricative- which are subject to some constraints of co-occurrence are those whose R_1 is filled with the labial f, or the pharyngeal ħ. It is noteworthy, at this stage, to state that the voiced counterparts of f and ħ exhibit the same constraints of co-occurrence. (cf. Sect. V.1.5).

IV.I.7 The O_1 position with $SI(R_1)=2$

The class of sounds whose SI=2 is made up of the [-cont ,+voiced]: b, d, and g. Below are examined syllables of the type O_1 R_1 where these segments participate as nuclei.

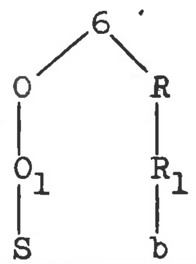
a) R_1=b

The data in (58) illustrate the segments that are attested in the non-branching onset of a syllable whose nucleus is filled with b:

(58)	$SI(O_1)=1$:	tb.bʒ 'follow Int.'	kb.bθ 'pour Int.'	qb.ba: 'cover Int.'
	$SI(O_1)=2$:	°bb	ddb.buz 'thick stick'	i.gb.bz 'that he fixed'

The segments attested in the O_1 position when the labial b is under the R_1 node are given in (59a), and the condition that specifies their sonority indices is in (59b):

(59) a.



b. If $SI(R_1)=2$, and $PA(R_1)=10$ then $SI(O_1) \leqslant 2$

S= t, k, q; d, g.

The filter in (60) below is formalized to rule out the unattested syllable °bb:

(60) $$\begin{array}{cccc} ^{\circ}\,O_1 & & R_1 & \\ | & & | & \\ [[-] & [10]] & [[2] & [10]] \end{array}$$

b.) $\underline{R_1=d}$

ATT forms such as those given in (61) indicate that when d is in the R_1 slot, the segments attested in the O_1 slot are those whose SI ≤ 2:

(61) $\underline{SI(O_1)=1}$:	td.dz 'she hits'	ik.kd 'he came by'	i.qd.da: 'he estimated'
$\underline{SI(O_1)=2}$:	kb.bd 'pour here'	Bd.dd 'stand here'	ig.gd 'he did here'

The data above support the generalization that the segments attested in the non-branching onset of a syllable O_1 R_1 -where R_1 is filled with d- are those whose SI ≤ 2, i.e., those listed in (59b) and the labial b. The condition that captures this fact is provided in (62) below:

(62) If $SI(R_1)=2$ and $PA(R_1)=9$
then $SI(O_1) \leq 2$

It should be noted that the syllable dd given in the data in (61) above is a hetero-morphemic one, viz. the segment d in the O_1 position belongs to the stem (Bdd 'stand') and the d in the R_1 position is the directional particle (d).

c) $\underline{R_1=g}$

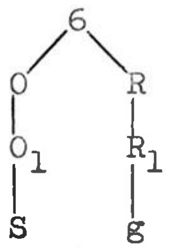
The ATT forms given in (63) illustrate the segments attested in the O_1 position when g is under R_1:

(63)

$SI(O_1)=1$:	,tg.giθ 'she does it'	°kg	°qg
$SI(O_1)=2$:	nb.bg 'go away'	a.dg.gn 'they'll do here'	°gg

The segments attested in the O_1 position when g is in the R_1 slot are listed in (64a), and the condition on the range of their sonority indices is given in (64b):

(64) a.



S= t; b, d.

b. If $SI(R_1)=2$, and $PA(R_1)=5$ then $SI(O_1)\leqslant 2$

The condition in (64b) generates the attested syllables tg, bg, and dg, as well as the unattested ones °kg, °qg, and °gg. To rule out these wrongly predicted syllables, a filter is provided in (65):

(65)
$$\begin{matrix} {}^{\circ}O_1 & & R_1 & \\ | & & | & \\ \left[[-] \right. & \left. [<9] \right] & \left[[2] \right. & \left. [5] \right] \end{matrix}$$

IV.1.8 The O_1 position with $SI(R_1)=1$

The lowest segments on the sonority scale in (3) that can fill the R_1 position are t, k, and g. We examine, below, the segments that are attested in the non-branching onset when anyone of these voiceless stops is in the R_1 slot.

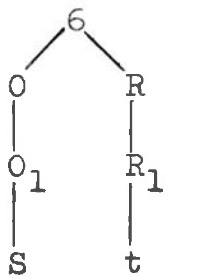
a) $\underline{R_1=t}$

The data below illustrate the segments attested in the O_1 position when <u>t</u> is under R_1:

(66) $\underline{SI(O_1)=1}$: a.tt.ta: 'she'll beg' kt.ta: 'add more' i.qt.ts 'he's miserable'

The data above indicate that in a syllable O_1 R_1, where R_1 is filled with <u>t</u>, any segment whose SI=1 can occur in the O_1 position. The segments in question are listed in (67a) and the condition on their sonority index is provided in (67b):

(67) a.



S= t, k, q.

b. If $SI(R_1)=1$, and $PA(R_1)=9$ then $SI(O_1) = 1$.

b) $\underline{R_1=k}$

The data in (68) indicate that <u>t</u> is the only segment attested in the O_1 position when <u>k</u> is in the R_1 slot:

(68) $\underline{SI(O_1)=1}$: tk.kθ 'go by Int.' °kk °qk

The condition on the sonority index of <u>t</u> is given in (69):

(69) If $SI(R_1)=1$, and $PA(R_1)=5$
then $SI(O_1)=1$

It is obvious that the condition in (69) generates the attested syllable <u>tk</u> as well as the unattested ones °<u>kk</u>, and °<u>qk</u>. The filter provided in (70) rules out these unattested syllables:

(70) $$^{\circ}\begin{array}{c} O_1 \\ | \\ \left[[-] \quad [<9] \right] \end{array} \quad \begin{array}{c} R_1 \\ | \\ \left[[1] \quad [5] \right] \end{array}$$

d) <u>R_1=q</u>

The forms given in (71) below show that the syllables <u>tq</u> and <u>qq</u> are attested in ATT:

(71) <u>SI(O_1=1:</u>	tq.qn 'close Int.'	°kq	ħq.qq 'stare at/ investigate'

The condition on the sonority index of the segments that occur in the O_1 position when <u>q</u> is under R_1 is given in (72):

(72) If SI(R_1)=1, and PA(R_1)=3
then SI(O_1)=1

The filter excluding the unattested syllable <u>°kq</u> is formalized in (73):

(73) $$\begin{array}{c} ^{\circ}O_1 \\ | \\ \left[[1] \quad [5] \right] \end{array} \quad \begin{array}{c} R_1 \\ | \\ \left[[1] \quad [3] \right] \end{array}$$

The discussion above of the co-occurrence of voiceless stops in the R_1 position with other segments (also voiceless stops) in the O_1 slot shows that it is possible to account for the sonority index attested in the O_1 position by one general condition instead of those in (67b), (69) and (72). This condition is stated in (74):

(74) If $SI(R_1)=1$
then $SI(O_1)=1$

IV.1.9 Coclusion

The discussion above of the co-occurrence restrictions that hold on O_1 R_1 syllables (or CV syllables) shows that a high percentage of the sequences predicted by the sonority conditions on the ATT syllable template are in fact attested in ATT in these adjacent positions. The segments that exhibit some constraints of co-occurrence with other segments are those articulated at the back part of the vocal tract (those which are assigned a PA index <5), the liquids l, and r, and the labials (with PA index =10).

These observations are reflected by the table in (75) where the (+) signs indicate that an O_1 R_1 syllable is attested (with R_1 filled with the segments on the horizontal line and O_1 with the segments on the vertical line). A (-) sign indicates that a syllable O_1 R_1 is not attested although predicted by the sonority conditions.

(75) <u>Table 1</u>: Attested and unattested O_1 R_1 syllables

O_1 \ R_1	a	i	u	l	f̂	r	m	n	B	ð	z	ẑ	ʒ	ɣ	h	f	θ	s	ŝ	x	ħ	b	d	g	t	k	q
j	+	+	+																								
w	+	+	+																								
l	+	+	+	−	−	−																					
f̂	+	+	+	−	−	−																					
r	+	+	+	−	−	−																					
m	+	+	+	+	+	−	+	+																			
n	+	+	+	+	+	−	+	+																			
B	+	+	+	+	+	−	−	+	−	+	+	+	+	+	+												
ð	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+												
z	+	+	+	+	+	−	+	+	+	+	+	−	+	+	+												
ẑ	+	+	+	−	+	−	+	+	+	+	−	−	+	+	+												
ʒ	+	+	+	+	+	−	+	+	+	+	+	+	−	+	−												
ɣ	+	+	+	−	+	−	+	+	+	+	+	+	−	+	−												
h	+	+	+	+	+	−	+	+	+	+	+	+	−	+	−												
f	+	+	+	+	+	−	+	+	−	+	+	+	+	+	+	−	+	+	+	+	+						
θ	+	+	+	−	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+						
s	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+						
ŝ	+	+	+	−	+	−	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+						
x	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+						
ħ	+	+	+	+	+	−	+	+	+	+	+	+	−	+	−	+	+	+	+	+	−						
b	+	+	+	+	+	−	+	+	−	+	+	+	+	+	+	−	+	+	+	+	+	−	+	+			
d	+	+	+	−	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+			
g	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+			
t	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
k	+	+	+	+	+	−	+	+	+	+	+	−	+	+	−	+	+	+	+	+	+	+	+	−	+	+	−
q	+	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	−	+	−

IV.2 <u>Branching onsets</u>

The goal of this section is to define the set of segments that can co-occur in the onset consituent. In other words, it seeks an answer to the following question: given a segment X in the O_1 position of a syllable, what are all the segments with $SI \leqslant SI(O_1)$ which can occur in the O_2 position? The procedure followed in answering this question is the same as the one adopted in the preceding section; i.e. to any segment that can fill the O_1 position, we shall provide all the segments predicted to fill the O_2 position in conformity with the template in (2a) and the sonority conditions in (2b). Those segments that are actually attested will be listed under the O_2 node, while those which are not attested although conforming to the sonority conditions, will be excluded by appropriate filters.

While examining the onset constituent, the segment filling the R_1 position is disregarded. This is so because of the limited scope of the present investigation where we do not attempt at capturing generalizations on non-adjacent syllable terminal positions such as the O_2 and the R_1 positions (for a different analysis see Boukous (1987)).

IV.2.1. The O_2 position with $SI(O_1)=7$

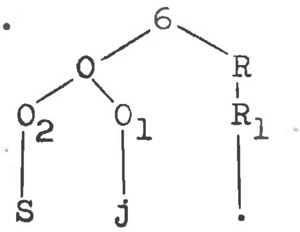
The two segments with a SI=7 that are eligible to fill the O_1 position are I and U. Once these two vocoids are effectively governed by the O_1 node they are realized as j and w respectively. Below are given data that exemplify the co-occurrence of these glides in the O_1 position with other segments in the O_2 slot.

a) $O_1=j$

The data in (76) below illustrate the set of segments attested in the O_2 position when j is under O_1:

(76)	$SI(O_2)=1$:	tju.ra 'she's behind Int.'	°ḳj	°qj	
	$SI(O_2)=2$:	°bj	°ḍj	°gj	
	$SI(O_2)=3$:	°fj	θja.want 'surfeit'	sju.ran 'they delayed'	
		°ŝj	xja: 'I see!'	ḥjaθ 'bring him back to life'	
	$SI(O_2)=4$:	°Bj	ɣja.ja.zn 'they are men'	z:jit 'milk it'	
		°ẑj	°ʒj	°ɣj	°hj
	$SI(O_2)=5$:	m:ja 'one hundred'	njin 'they climbed'		
	$SI(O_2)=6$:	ljum 'today'	°r̂j	°rj	
	$SI(O_2)=7$:	°jj	°wj		

The segments attested in the O_2 position when O_1=j are given in (77a) , and the condition on their sonority indices is formalized in (77b):

(77) a. 

b. If $SI(O_1)=7$, and $PA(O_1)=5$ then $SI(O_2) \lll 6$

S= t; θ, s, x, ħ; ð, z;m, n; l.

The filter which excludes the unattested onset clusters given in (76) above is provided below:

(78)
$$\begin{array}{c} {}^{\circ}O_2 \\ \left\{\begin{array}{lcr} [[<5] & [& 10]] \\ [[2] & [& 9]] \\ [[6] & [& 9]] \\ [[1] & [& 3]] \\ [[-] & [4 & <n \lll 7]] \\ [[3] & [& \lll 4]] \end{array}\right\} \end{array} \quad \begin{array}{c} O_1 \\ [[7] \quad [5]] \end{array}$$

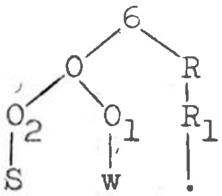
b) <u>O_1=w</u>

ATT forms such as those in (79) below whow the set of segments attested in the O_2 position when O_1=w:

(79) <u>$SI(O_2)=1$:</u>	twa.ʕa 'she sees'	°kw	qwan 'they're strong'
<u>$SI(O_2)=2$:</u>	°bw	d:wa 'medecine'	° gw
<u>$SI(O_2)=3$</u>	°fw	θwa.ʕa 'once'	swin 'they drank'
	ŝwa 'fry'	xwa.lu 'on nothing'	°ħw

SI(O_2)=4:	°Bw	ðwin 'they flew'	zwa 'cross'
	ẑwa 'moan'	ʒwan.ti 'my aunts'	ɣwa 'tempt'
	hwa 'go down'		
SI(O_2)=5:	mwan.zan 'the one with a big nose'	nwa 'intend'	
SI(O_2)=6:	lwalidin 'parents'	r̂war.raθ 'damned thing'	°rw
SI(O_2)=7:	°jw	°ww	

The segments attested in the O_2 position when <u>w</u> is in the O_1 position are given in (80a), and the condition on their range of sonority indices is provided in (80b):

(80) a. 

b. If SI(O_1)=1 and PA(O_1)=4 then SI(O_2) $\leqslant$ 6

S=t, q; d; θ, s, ŝ, x; ð, z, ẑ, ʒ, ɣ, h; m, n; l, r̂.

The excluded onset clusters which are indicated in (79) above are excluded by the filter in (81) below:

(81)
$$^{\circ}\begin{array}{cc} O_2 & O_1 \\ \left\{\begin{array}{l} [[-]\ [5]] \\ [[3]\ [2]] \\ [[-]\ [7]] \\ [[-5]\ [10]] \\ [[3]\ [2]] \end{array}\right\} & [[7]\ \ [4]] \end{array}$$

A comparison of the condition in (77b) with that in (80b) shows that when j is in the O_1 position, the dissimilarity index between the O_1 position and the O_2 slot is 1; that is, the segments attested in the O_2 slot when j is in the R_1 position have a SI$\leqslant$6. The same is true of the case wherein w is in the O_1 position. This makes it possible to group the conditions in (77b) and (80b) in one general condition as in (82):

(82) If $SI(O_1)=7$
then $SI(O_2)\leqslant 6$

The filters in (78) and (81) are necessary to exclude the wrongly predicted (or unattested) clusters.

IV.2.2 The O_2 position with $SI(O_1)=6$

The sonority index 6 groups the three liquids l, ꝛ, and r. The co-occurence of these liquids in the O_1 slot with other segments in the O_2 position is examined below.

a) O_1=l

The data given in (83) below illustrate the set of segments attested in the O_2 position when l is in the O_1 slot:

(83)	$SI(O_2)=1$:	tla.la 'she chases Int.'	°kl	°ql
	$SI(O_2)=2$:	°bl	°dl	°gl

<u>$SI(O_2)=3$:</u>	°fl	θla.la 'she chased'	°xl
	s:lak 'making do'	°ŝl	°ħl
<u>$SI(O_2)=4$:</u>	°Bl	°ðl	°zl
	°ẑl	°ʒl	°ɣl
	°hl		
<u>$SI(O_2)=5$:</u>	°ml	°nl	
<u>$SI(O_2)=6$:</u>	°ll	°r̂l	°rl

The scarcity of forms with <u>l</u> was explained in (Chap.I. Sect.3). It was pointed out earlier that <u>l</u> is realized as <u>r̂</u> in most loan-words. This might be the reason behind the very limited set of segments attested in the O_2 position when <u>l</u> is in the O_1 slot.

The condition in (84) below states that when <u>l</u> is in the O_1 position the segments attested in the O_2 slot have a SI $\leqslant 3$:

(84) If $SI(O_1)=6$, and $PA(O_1)=8$

then $SI(O_2) \leqslant 3$

The exclusion of the unattested clusters indicated in the data in (83) above is effected by the filter in (85):

(85)
$$\overset{*O_2}{\left\{\begin{bmatrix}[-] & [<8]\\ \end{bmatrix} \atop {\begin{bmatrix}[2] & [9]\end{bmatrix} \atop \begin{bmatrix}[-] & [10]\end{bmatrix}}\right\}} \quad \overset{O_1}{\begin{bmatrix}[6] & [8]\end{bmatrix}}$$

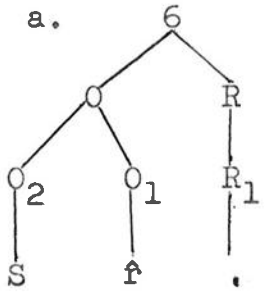
b) $\underline{O_1=\hat{r}}$

ATT forms such as those in (86) illustrate the segments attested in the O_2 position when $\underline{\hat{r}}$ is under O_1:

(86) $\underline{SI(O_2)=1}$:	tr̂az 'be hungry Int.	°kr̂	qr̂a 'fry'
$\underline{SI(O_2)=2}$:	°br̂	°dr̂	°gr̂
$\underline{SI(O_2)=3}$:	fr̂an 'a certain person'	θr̂a.θa 'three'	sr̂ir̂ 'wash'
	ŝr̂uḥ 'Berbers of the Atlas)'	xr̂u.r̂uf 'on thousands'	ḥr̂ar̂ 'allowed (religious connotation)'
$\underline{SI(O_2)=4}$:	Br̂a 'provoke'	ð̆r̂iθ 'cover him'	zr̂i 'twist'
	ẑr̂a 'drive away	ʒr̂i 'person's name	ɣr̂i 'disappear'
	°hr		
$\underline{SI(O_2)=5}$:	mr̂i 'if'	nr̂a.qa 'we're contamiminated'	
$\underline{SI(O_2)=6}$	°lr̂	°r̂r̂	°rr̂

The data in (86) display the set of segments that are attested in the O_2 position when the liquid $\underline{\hat{r}}$ is in the O_1 slot. These segments are listed in (87a), and the condition that specifies their sonority indices is given in (87b):

(87) a.



b. If $SI(O_1)=6$, and $PA(O_1)=9$ then $SI(O_2) \leqslant 5$

S= t,q ; f, θ, s, ŝ, x, ħ; B, ð, z, ẑ, ʒ, ɣ; m, n.

The filter excluding the unattested O_2 O_1 sequences <u>°bf̂</u>, <u>°df̂</u>, <u>°gf̂</u>, <u>°kf̂</u>, and <u>°hf̂</u> is given in (88) below:

(88)
$$\begin{array}{cc} {}^{\circ}O_2 & O_1 \\ \left\{ \begin{array}{c} \left[[+]\ [1] \right] \\ \left[[1]\ [5] \right] \\ \left[[2]\ [-] \right] \end{array} \right\} & \left[[6] \quad [9] \right] \end{array}$$

c) <u>O_1=r</u>

The co-occurrence of <u>r</u> in the O_1 position with other segments in the O_2 slot is illustrated by the data below:

(89)

<u>$SI(O_2)=1$:</u>	tra.ẑa 'wait Int.'	°kr	°qr
<u>$SI(O_2)=2$:</u>	°br	dara 'corn'	°gr
<u>$SI(O_2)=3$:</u>	fru.ri 'hatch'	θru 'she cried'	sru 'pull out'
	ŝ:raB 'wine'	°xr	ħ:ri 'grind'
<u>$SI(O_2)=4$:</u>	Bri 'grind'	ðri.fa 'person's name'	zrin 'they saw'
	°ẑr	°ʒr	°ɣr
	°hr		

SI(O_2)=5: °mr nru
'we cried'

SI(O_2)=6: °lr °r̂r °rr

The set of attested clusters when r is in the O_1 slot is: tr, d:r; fr, sr, ŝr, ħr, Br, or, zr; and nr. The condition which specifies the range of sonority indices of the segments attested in the O_2 position is given in (90):

(90) If SI(O_1)=6, and PA(O_1)=7
then SI(O_2)$\leqslant$5

The filter excluding the unattested clusters given in (89) above is formalized in (91) below:

(91)
$$\begin{array}{ll} {}^{\circ}O_2 & O_1 \\ \left\{\begin{matrix} [[2]\;[10]] \\ [[5]\;[10]] \\ [[<4]\;[2<n<6]] \\ [[4]\;[<7]] \end{matrix}\right\} & [[6]\qquad[7]] \end{array}$$

The condition in (84) above states that the dissimilarity index between the O_2 position and the O_1 slot filled with l is 3. That is, no segments with a SI>3 are attested in the O_2 position of a branching onset whose O_1 is occupied by l. By contrast, the conditions in (87b) and (90) show that the dissimilarity index between the O_2 slot and the O_1 position when the latter is filled with either r̂ or r is 1.

IV.2.3 The O_2 position with $SI(O_1)=5$

The sonority scale in (3) above indicates that the nasals m and n are the only segments whose SI=5. The discussion below shows the set of segments attested in the O_2 position when either of the nasals above is in the O_1 slot.

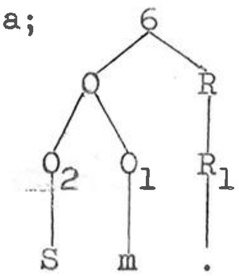
a) O_1=m

The data in (92) below exemplify the attested O_2 O_1 clusters when m is under O_1:

(92)	$SI(O_2)=1$:	tmaf̂.f̂a 'she's in a hurry'	kmum.mŝ 'coil'	qmi 'strangle'
	$SI(O_2)=2$:	°bm	d:ma.jaθ 'pool of blood'	°gm
	$SI(O_2)=3$:	°fm	θma 'edge'	smun 'gather
		ŝ:mat 'rogue'	xmi 'when'	ħma.ma 'person's name'
	$SI(O_2)=4$:	°Bm	ðma.lik 'it is Malik'	zmum.mi 'smile'
		°ẑm	ʒma: 'person's name'	ɣmi 'grow up'
		°hm		
	$SI(O_2)=5$:	°mm	nmun 'we gathered'	

The segments attested in the O_2 position when m is under O_1 are listed in (93a) and the condition that specifies their sonority indices is in (93b):

(93) a;



b. If $SI(O_1)=5$, and $PA(O_1)=10$ then $SI(O_2) \leqslant 5$

S= t, q, k; d; θ, s, ŝ, x, ħ; ð, z, ʒ, ɣ; n.

The filter exculding the unattested O_2 O_1 clusters is given in (94):

(94)
$$
{}^{\circ}O_2 \left\{ \begin{bmatrix} [-] & [10] \\ [2] & [5] \\ [4] & [6] \\ [-] & [1] \end{bmatrix} \right\} \quad O_1 \begin{bmatrix} [5] & [10] \end{bmatrix}
$$

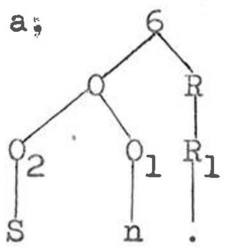
b) $\underline{O_1=n}$

The segments that occur in the O_2 position when n is in the O_1 slot are illustrated by the data in (95):

(95)	$\underline{SI(O_2)=1}$:	tna 'get stucked Intr'	knun.na: 'roll'	qnu.ni 'roll over'
	$\underline{SI(O_1)=2}$:	°bn	d:nuB 'guilt'	°gn
	$\underline{SI(O_2)=3}$:	fnan 'they're 'eshausted'	θna.jn 'two'	sna.ẑat 'with Najat'
		ŝnan 'they are	xnun.ns 'get dry'	ħnun.nð 'coil'

SI(O_2)=4:	Bna 'build'	ð̌nu.nut 'it is Nunut'	znu.za 'sell Int.'
	ẑnin 'they slept'	ʒnun.nẑ 'be uppish'	ɣ̌na 'make rich'
	hna 'be in peace'		
SI(O_2)=5:	mnan.nas 'the one with big buttocks'	°nn	

The first elements in the attested clusters O_2 O_1 where O_1=n are given in (96a) and the condition on their sonority indices is in (96b):

(96) a; 

b. If SI(O_1)=5, and PA(O_1)=9 then SI(O_2)$\leqslant$5

S= t, k, q; d:; f, θ, s, ŝ, x, ħ; B, ð̌, z, ẑ, ʒ, ɣ̌, h; m.

The condition in (96b) above predictes the attested onset clusters as well as the unattested ones °bn, °gn and °nn. The latter are ruled out by the filter in (97) below:

(97)
$$
{}^{\circ}\begin{array}{cc} O_2 & O_1 \\ \left\{\begin{matrix} [[2] & [5]] \\ [[5] & [9]] \\ [[2] & [10]] \end{matrix}\right\} & [[5] \quad [9]] \end{array}
$$

The conditions in (93b) and (96b) can be expressed by one general condition, which is given in (98) below:

(98) If $SI(O_1) = 5$

then $SI(O_2) \leqslant 5$

From the condition in (98) above, it can be deduced that the dissimilarity index between the O_2 position and the O_1 position filled by either m or n is 0. That is, any segment whose $SI \leqslant 5$ can occur in the O_2 position when m or n is under O_1.

IV.2.4 The O_2 position with $SI(O_1)=4$

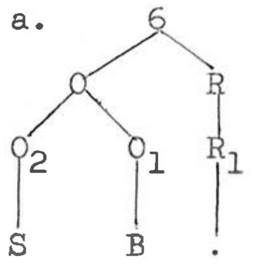
The segments dealt with in this section are: B, ɣ̃, z, ẑ, ʒ, ɣ, and h. The co-occurence of these fricatives in the O_1 position with other segments in the O_2 slot is examined below:

a) $O_1=B$

(99) $SI(O_2)=1$:	tBar.rah 'call Int'	qBa: 'cover'	°kB
$SI(O_2)=2$:	°bB	d:Ba.rẑ 'bracelets'	°gB
$SI(O_2)=3$:	°fB	θBa:ɣ̃ 'she cooled down'	sBa: 'be patient'
	°ŝB	xBa.Bas 'on his father'	°ħB
$SI(O_2)=4$:	°BB	ɣ̃Ba.Ba 'it is my father'	zBa: 'hurt'
	ẑBa: 'mend'	ʒBa: 'measure'	ɣBn 'deprive'
	°hB		

The segments that are attested in the O_2 position when the labial B is in the O_1 position are given in (100a) and the condition on their sonority indices is provided in (100b):

(100) a.



b. If $SI(O_1)=4$, and $PA(O_1)=10$ then $SI(O_2)\leqslant 4$

S= t, q, d; θ, s, x; ð, z, ẓ, ʒ, ɣ.

The filter excluding the unattested onset clusters is formalized in (101):

(101)

$$
{}^{*}\begin{array}{cc} O_2 & O_1 \\ \left\{\begin{array}{c} \left[\,[3] \quad [2]\,\right] \\ \left[\,[3] \quad [6]\,\right] \\ \left[\,[4] \quad [1]\,\right] \\ \left[\,[-] \quad [5]\,\right] \\ \left[\,[-] \quad [10]\,\right] \end{array}\right\} & \left[\,[4] \qquad [10]\,\right] \end{array}
$$

b) O_1=ð

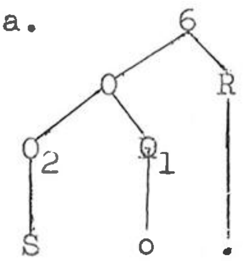
ATT forms such as those given in (102) illustrate the attested onset clusters where O_1=ð:

(102) $SI(O_2)=1$:	t:ðiθ 'suck it'	kða 'something'	qðu 'cut'
$SI(O_2)=2$:	°bð	d:ðn ''they sweat'	°gð
$SI(O_2)=3$:	fðaθ 'save him'	s:ðr 'cause to hatch'	ṣða: 'be alert'
	xðm 'work'	ħða 'guard'	°θð

$SI(O_2)=4$: Bð̌a 'start'	°ð̌ð̌	zð̌m 'gather wood'
ẑ:ð̌am 'prickle'	ʒð̌m 'hurt'	ɣ̌ð̌a: 'commit treason'
hð̌a 'eat grass'		

The segments attested in the O_2 position when O_1=ð̌ are given in (103a), and the condition that specifies their range of their sonority indices is formalized in (103b):

(103) a.



b. If $SI(O_1)=4$, and $PA(O_1)= 9$ then $SI(O_2)\leqslant 4$

S= t, k, q; d; f, s, ŝ, x, ħ; B, z, ẑ, ʒ, ɣ̌, h.

Since the condition in (103b) generates the unattested onset clusters °bð̌, °qð̌, °θð̌, and °ð̌ð̌, these are to be ruled out by a filter, which is given in (104) below:

(104)
$$\begin{array}{ccc} {}^{\circ}O_2 & & O_1 \\ \left\{\begin{array}{l} \left[[\ 2] \quad [10]\right] \\ \left[[>2] \quad [\ 9]\right] \\ \left[[\ 2] \quad [\ 5]\right] \end{array}\right\} & & \left[[4] \quad [9]\right] \end{array}$$

c) O_1=z

The attested onset clusters where O_1=z are exemplified by the data in (105):

(105) <u>SI(O_2)=1:</u> ,tzm.ma: 'whistle Int.' °kź °qz

<u>SI(O_2)=2:</u> °bz dẓzn 'they hit' °gz

<u>SI(O_2)=3:</u> f:zn they chewed' θziz.wit 'à bee' °sz

°ŝz xza:n 'they ħzn 'be sad'

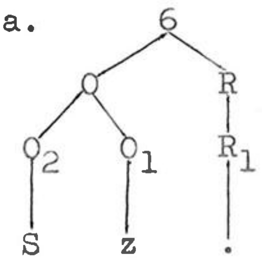
<u>SI(O_2)=4:</u> Bza: 'spread' ð̆zum.bi 'it is corn' °zz

ẑz ẓzm 'be quick' ɣzun 'they're right'

hzm 'defeat'

The segments attested in the O_2 position when the alveolar <u>z</u> is in the O_1 are provided in (106a) and the condition on their sonority indices is in (106b):

(106) a.



b. If SI(O_1)=4, and PA(O_1)=8 then SI(O_2)$\leqslant$4

S= t;d; f, θ, x, ħ; B, ð̆, ʒ, ɣ, h.

The filter excluding the unattested onset clusters indicated by the data in (105) is given in (107):

(107)

$$\begin{array}{ll} {}^{\circ}\underset{|}{O_2} & \underset{|}{O_1} \\ \left\{\begin{array}{l} \left[[\ 2]\ \ [10]\right] \\ \left[[>2]\ \ [\ 8\ ]\right] \\ \left[[\ -]\ \ [4<n<7]\right] \\ \left[[\ 1]\ \ [\ 3\ ]\right] \end{array}\right\} & [4] \qquad [8] \end{array}$$

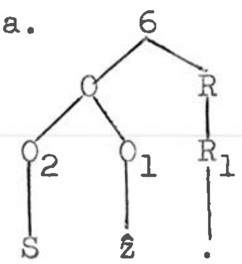
d) O_1=ẑ

The segments attested in the O_2 position when the voiced fricative ẑ is in the O_1 position are illustrated by the data given in (108):

(108)			
SI(O_2)=1:	tẑa.wa: 'be pregnant'	°kẑ	qẑiẑ.ẑu 'freeze'
SI(O_2)=2:	°bẑ	°dẑ	°gẑ
SI(O_2)=3:	°fẑ	θẑm.3iθ 'she gathered it'	sẑa.da 'praying mat'
	°ŝẑ	xẑa.mil 'on Jamil'	ħẑB 'put on
SI(O_2)=4:	°Bẑ	ðẑa.mal 'it is Jamal'	°zẑ
	°ẑẑ	3ẑn 'step over'	°ɣẑ
	hẑm 'attack'		

The first elements of the onset clusters when O_1 is filled with ẑ are given in (109a) and the condition on their sonority indices is formalized in (109b):

(109) a.



b. If SI(O_1)=4, and PA(O_1)=6 then SI(O_1)$\leqslant$4

S= t, q; θ, s, x, ħ; ð, 3, h

The large number of unattested onset clusters justifies the relatively complex filter in (110):

(110) $$\begin{array}{c} {}^{\circ}O_2 \qquad\qquad\qquad O_1 \\ \left\{\begin{matrix} [[-] & [10]] \\ [[-] & [5]] \\ [[-] & [6]] \\ [[4] & [8]] \\ [[4] & [4]] \\ [[2] & [9]] \end{matrix}\right\} \quad [[4] \qquad [6]] \end{array}$$

e) $\underline{O_1 = ʒ}$

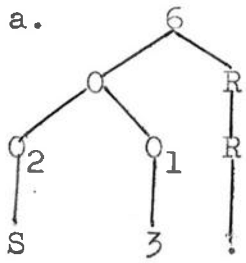
The forms provided in (111) illustrate the co-occurrence of ʒ in the O_1 position with other segments in the O_2 position:

(111)

$\underline{SI(O_2)=1}$:	tʒa.wað 'repeat Int.'	°kʒ	°qʒ
$\underline{SI(O_2)=2}$:	°bʒ	dʒa 'take to court'	°gʒ
$\underline{SI(O_2)=3}$:	θʒan 'she pushed'	fʒř 'do'	sʒum: 'cause to bathe'
	ŝ:ʒa: 'hair'	xʒam 'on a year'	°ħʒ
$\underline{SI(O_2)=4}$:	°Bʒ	ðʒn 'surrender'	zʒm 'dare'
	ẑʒuʒ.ʒi 'appear'	°ʒʒ	°ɣʒ
	°hʒ		

The segments attested in the O_2 position when ʒ is in the O_1 slot are given in (112a) and the condition on their sonority indices is given in (112b):

(112) a.



b. If $SI(O_1)=4$, and $PA(O_1)=2$ then $SI(O_2) \ll 4$

S= t; d; θ, f, s, ŝ, x; ð, z, ẑ.

The filter in (113) rules out the unattested onset clusters with O_1=3:

(113)
$$
{}^{\circ}\begin{array}{c} O_2 \\ \left\{\begin{bmatrix} [4] & [10] \\ [2] & [10] \\ [-] & [5] \\ [4] & [4] \\ [-] & [<4] \end{bmatrix}\right\} \end{array}
\quad
\begin{array}{c} O_1 \\ \begin{bmatrix} [4] & [2] \end{bmatrix} \end{array}
$$

f) <u>O_1= ɣ</u>

The ATT forms given in (114) exemplify the set of segments attested in the O_2 position when <u>ɣ</u> is in the O_1 slot:

(114)

<u>$SI(O_2)=1$:</u>	tɣaB 'she absents, Int'	°kɣ	°qɣ
$SI(O_2)=2$:			
<u>$SI(O_2)=2$:</u>	°bɣ	°dɣ	°gɣ
<u>$SI(O_2)=3$:</u>	θɣat 'she-goat'	°fɣ	sɣit 'buy it'
	ŝɣr̂ 'busy'	°xɣ	°ħɣ

<u>SI(O_2)=4:</u>	°Bγ	δγa.nim 'it's a bamboo'	zγax 'from us'
	°ẑγ	°ʒγ	°γγ
	°hγ		

The data in (114) above show that the only segments attested in the O_2 position when <u>γ</u> is in the O_1 slot are: <u>t</u>, <u>θ</u>, <u>s</u>, <u>ŝ</u>, <u>δ</u>, and <u>z</u>. The range of the sonority indices of these segments is specified by the condition in (115):

(115) If SI(O_1)=4, and PA(O_1)=4
then SI(O_2) ≤ 4

The filter excluding the unattested onset clusters when O_1=<u>γ</u> is formalized in (116) below:

(116)
$$*\begin{array}{cc} O_2 & O_1 \\ \left\{\begin{array}{l} [[-] \quad [5]] \\ [[-] \quad [10]] \\ [[2] \quad [9]] \\ [[4] \quad [6]] \end{array}\right\} & [4] \quad [4] \end{array}$$

It must be pointed out that the unattested clusters indicated by the data in (114) above far outnumber the attested ones. A phenomenon which is not characteristic of onset clusters when <u>γ</u> is in the O_1 position, since the same observation applies to onset clusters where O_1=<u>ʒ</u> (cf.(112a) above).

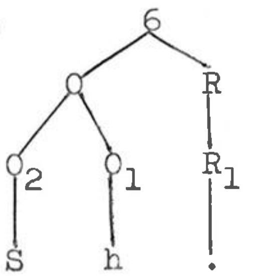
g) <u>O_1=h</u>

The ATT forms provided in (117) exemplify the set of attested onset clusters when O_1=<u>h</u>:

(117) <u>SI(O_2)=1:</u>	ˌtha.waŝ 'talk nonsense'	°kh	ˌqha: 'defeat'
<u>SI(O_2)=2:</u>	°bh	d:hn 'butter'	°gh
<u>SI(O_2)=3:</u>	θhn.naθ 'she gave him peace'	fhm 'under-stand'	sha 'be absent-minded'
	ŝha: 'one month'	°xh	°ħh
<u>SI(O_2)=4;</u>	Bha: 'astonish'	ðhn 'cream'	zha 'enjoy oneself'
	ẑhr̂ 'become mad'	°ʒh	°ɣh
	°hh		

The segments attested in the O_2 position when <u>h</u> is in the O_2 slot are given in (118a) and the condition on their sonority indices is expressed by (118b)

(118) a.



b. If SI(O_1)=4, and PA(O_1)=1 then SI(O_2) $\leqslant$4

S= t, q; d; f, θ, s, ŝ; B, ð, z, ẑ.

The filter excluding the unattested onset clusters is given in (119):

(119)
$$\begin{array}{cc} {}^{\circ}O_2 & O_1 \\ \left\{\begin{matrix} [[-] & [\leqslant 2\ ]] \\ [[2] & [3<n<6]] \\ [[2] & [\ 10\ ]] \end{matrix}\right\} & [[4] \quad [1]] \end{array}$$

The discussion of the co-occurrence of voiced fricatives in the O_1 position with other segments in the O_2 slot, reveals that the latter position can be occupied by segments whose sonority indices range from 4 to 1 (i.e., from voiced fricatives to voiceless stops); this justifies the general condition on the range of sonority indices of the segments attested in the O_2 position, which is formalized in (120) below:

(120) If $SI(O_1)=4$
then $SI(O_2)\leqslant 4$

The condition above implies that segments with equal sonority indices (here SI=4) can co-occur in the O_2 O_1 sequence. In other words, the dissimilarity index between the O_2 position and the O_1 slot when the latter is filled with a voiced fricative is 0.

A final note about the class of voiced fricatives (i.e. the class of segments whose PA=4) is that the back segments <u>ɣ</u> and <u>ʒ</u> exhibit constraints of co-occurrence on the adjacent position (O_2) more than does the back segment <u>h</u>. The dental <u>ð</u>, on the other hand, co-occurs with a wide range of segments whose SI$\leqslant$4 (see table 2 in (157) below).

IV.2.5 The O_2 position with $SI(O_1)=3$

There are six segments which have a SI=3 : f, θ, s, ŝ, x and ħ. The co-occurrence of these segments in the O_1 position with other segments in the O_2 slot is examined below:

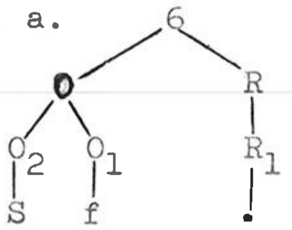
a) O_1=f

The segments attested in the O_2 position when f is in the O_1 slot are illustrated in (121):

(121) $SI(O_2)=1$:	tfað 'she is thirsty Int.'	kfa 'enough'	qff 'close'
$SI(O_2)=2$:	°bf	d:fin 'caftan'	g:fas.sn 'in the hands'
$SI(O_2)=3$:	°ff	θfawt 'light'	sfað 'with thirst'
	ŝfa 'see'	xfarid 'on Farid'	ħfan 'they're blunt'

The segments attested in the O_2 position when O_1 is filled with f are given in (122a) and their sonority indices are specified by the condition in (122b):

(122) a.



b. If $SI(O_1)=3$, and $PA(O_1)=10$ then $SI(O_2) \leqslant 3$

S= t, k, q, d, g, θ, s, ŝ, x, ħ.

The unattested clusters °bf and °ff̂ are excluded by the filter in (123) below:

(123)

$$\begin{array}{cc} O_2 & O_1 \\ | & | \\ \left[\begin{array}{cc}[-] & [10]\end{array}\right] & \left[\begin{array}{cc}[3] & [10]\end{array}\right]\end{array}$$

b) $O_1 = \theta$

The data in (124) exemplify the attested onset clusters with θ in the O_1 position:

(124)

$SI(O_2)=1$:	°tθ	kθa: 'more'	°qθ
$SI(O_2)=2$:	°bθ	°dθ	°gθ
$SI(O_2)=3$:	fθf̂ 'roll couscous'	°θθ	sθa 'with this one'
	ŝθi 'take'	xθa 'on this one Fem.'	ħθŝ 'cut grass'

The segments attested in the O_2 position when the coronal fricative θ is in the O_1 slot are: k; f, s, ŝ, x and ħ. The conditions on their sonority indices are formalized in (125):

(125) If $SI(O_1)=3$, and $PA(O_1)=9$
then $SI(O_2) \leqslant 3$

The unattested onset sequences: °tθ, °qθ, °bθ, °dθ, °gθ and °θθ are ruled out by the filter given in (126):

(126)
$$
\begin{array}{cc}
{}^{\circ}O_2 & O_1 \\
\left\{\begin{array}{c}
\left[\,[2] \quad [5]\,\right] \\
\left[\,[1] \quad [3]\,\right] \\
\left[\,[-] \quad [9]\,\right] \\
\left[\,[2] \quad [10]\,\right]
\end{array}\right\}
&
\left[\,[3] \qquad [9]\,\right]
\end{array}
$$

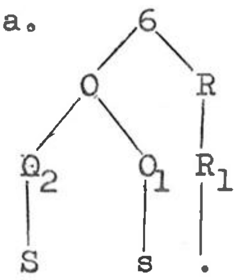
It can be noted that when $\underline{\theta}$ is in the O_1 position, the set of ~~segments~~ attested in the O_2 position is very limited, and that -unlike its voiced couterpart (cf. IV.2.4 b)) above- the coronal $\underline{\theta}$ does not co-occur with other coronal segments in the O_2 position.

c) <u>O_1=s</u>

The ATT forms given in (127) below exemplify the segments attested in the O_2 position when O_1 is filled with <u>s</u>:

(127) <u>SI(O_2)=1:</u>	tsa:.ra 'she's out for a walk'	ksB 'own'	q:sn 'they hurt'
<u>SI(O_2)=2:</u>	°bs	d:sas 'foundation'	°gs
<u>SI(O_2)=3:</u>	fsi 'untie'	θsa 'liver'	°ss
	°ŝs	xsn 'they like'	ħsB 'count'

The segments that occur in the O_2 position when <u>s</u> is in the O_1 position are provided in (128a) and the range of their sonority indices is specified by the condition in (128b):

(128) a. 

b. If $SI(O_1)=3$, and $PA(O_1)=8$ then $SI(O_2) \leqslant 3$

S= t, k, q; d:, f, θ, x, ħ.

The unattested onset clusters given in (127) above are excluded by the filter in (129):

(129)
$$^{\circ}\left\{\begin{matrix} O_2 \\ \left[[2] \quad [10]\right] \\ \left[[>1] \quad [5 \leqslant n \leqslant 8]\right] \end{matrix}\right\} \begin{matrix} O_1 \\ \left[[3] \quad [8]\right] \end{matrix}$$

The set of voiceless fricatives that occur in the O_2 position when s is under O_1 is the same as that which is attested in the O_2 position when z (the voiced correspondent of s) is in the O_1 slot.

d) O_1=ŝ

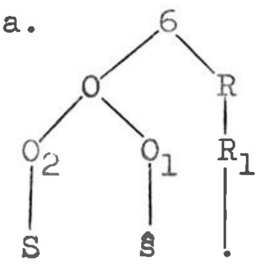
The set of segments attested in the O_2position when ŝ is in the O_2 slot is illustrated by the data in (130):

(130)

$SI(O_2)=1$:	t:ŝa 'insert'	°kŝ	°qŝ
$SI(O_2)=2$:	°bŝ	d:ŝa: 'village'	°ĝŝ
$SI(O_2)=3$:	fŝf 'fail'	θŝawt 'big pain'	s:ŝa: 'be drunk'
	°ŝŝ	xŝa 'on Sth.'	ħŝa 'profit'

The segments that occur in the O_2 position when <u>ŝ</u> is under O_1 are given in (131a) and the condition in (131b) specifies the range of their sonority indices:

(131) a.

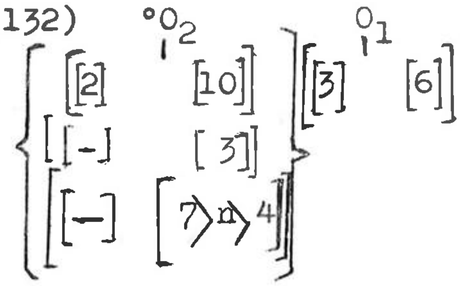


b. If $SI(O_1)=3$, and $PA(O_1)=6$ then $SI(O_2) \leqslant 3$

S= t; d:; f, θ, s:, x, ħ.

The unattested clusters indicated in (130) above are excluded by the filter in (132):

(132)



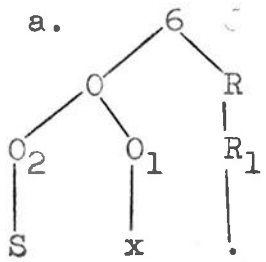
e) <u>O_1=x</u>

The data in (133) illustrate the segments attested in the O_2 position when the velar <u>x</u> is in the O_1 slot:

(133) <u>$SI(O_2)=1$:</u>	txm.maf 'hide Int'	°kx	°qx
<u>$SI(O_2)=2$:</u>	°bx	d:xa.xn 'thick smoke'	°gx
<u>$SI(O_2)=3$:</u>	fxa: 'boast'	θxa.ʕnt 'ring'	sxa 'be generous'
	ŝxa: 'snoar'	°xx	°ħx

The first elements in the attested O_2 O_1 clusters (i.e., those occurring in the O_2 position) are given in (135a) and the condition on their sonority indices is formalized in (136b):

(134) a.



b. If $SI(O_1)=3$, and $PA(O_1)=4$ then $SI(O_2) \ll 3$

S= t; d:; f, θ, s, ŝ.

The segments predicted to occur in the O_2 position by the condition in (135b) and which are not attested in that position are ruled out by the filter in (136):

(135)

$$\begin{array}{cc} {}^{\circ}O_2 & O_1 \\ \left\{\begin{matrix} \begin{bmatrix} [2] & [10] \end{bmatrix} \\ \begin{bmatrix} [-] & [\ll 5] \end{bmatrix} \end{matrix}\right\} & \begin{bmatrix} [3] & [4] \end{bmatrix} \end{array}$$

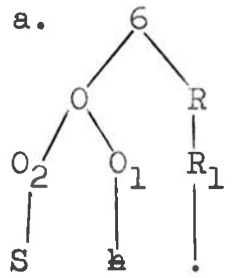
None of the back segments q̲, k̲, g̲, x̲, or ħ̲ occurs in the O_2 position when x̲ is in the O_1 slot, a fact which was noted when we dealt with the voiced correspondent of x̲, i.e. ɣ̲.(cf.Sect. IV.4 f) above).

f) O_1=ħ

ATT forms such as those in (136) below exemplify the set of segments attested in the O_2 position when the pharyngeal ħ̲ is in the O_1 slot:

(136) <u>SI(O_2)=1:</u>	tħa.ǯa^ 'touch Int.'	°kħ	°qħ
<u>SI(O_2)=2:</u>	°bħ	ḍ:ħuf̂ 'pretention'	°għ
<u>SI(O_2)=3:</u>	°fħ	θħa.ẑit 'tale'	sħa.la.wa 'with sweets
	ŝħaf̂ 'how much'	xħa.mid 'on Hamid'	°ħħ

The segments that occur in the O_2 position when <u>ħ</u> is in the O_1 slot are listed in (137a), while their sonority indices are specified by the condition in (137b):

(137) a. 

b. If SI(O_1)=3, and PA(O_1)=2 then SI(O_2) $\leqslant 3$

S= t; d:;θ, s, ŝ, x.

The unattested onset clusters where O_1=<u>ħ</u> are ruled out by the filter given in (138):

(138)
$$^{\circ}\begin{array}{cc} O_2 & O_1 \\ \left\{\begin{array}{l} [[-]\quad[10]] \\ [[-]\quad[5]] \\ [[-]\quad[\leqslant 3]] \end{array}\right\} & [[3]\quad[2]] \end{array}$$

It is worth noting that the back segments <u>k</u>, <u>q</u>, <u>g</u>, and <u>ħ</u> which are excluded from the O_2 slot when O_1=<u>ħ</u> are also unattested in the O_2 position when <u>ʒ</u> -the voiced correspondent of <u>ħ</u>- is in the O_1 slot (cf. IV.2.4 e) above).

The discussion of the co-occurrence of the voiceless fricatives in the O_1 position with other segments in the O_2 slot reveals that the dissimilarity index between the two onset positions when $SI(O_1)=3$ is 0. That is, when a segment whose SI=3 occurs in the O_1 position, the segments attested in the O_2 position range from voiceless stops to voiceless fricatives.

IV.2.6 The O_2 position with $SI(O_1)=2$

The sonority scale in (3) above indicates that the class of segments whose SI=2 are the voiced stops: b, d and g. The discussion below brings to light the various constraints that govern onset clusters where $SI(O_1)=2$.

a) O_1=b

It was noted earlier (cf. Chap.I., Sect. 5) that the labial stop b is realized as B when it is not preceded by the nasal m. The geminate b: (which is treated here on a par with its non-geminate counterpart b) is attested in the O_1 position. Yet, when this geminate is in the O_1 slot, no other segment is attested in the O_2 position. The condition which states that if geminate b: occurs in the O_1 position, the O_2 position is empty is given in (139):

(139) If $SI(O_1)=2$, and $PA(O_1)=10$

then $O_2=\emptyset$

b) O_1=d

When d is in the O_1 position, the only segment attested in the O_2 position is g, as shown by (140):

(140) SI(O_2)=1:	°td	°kd	°qd
SI(O_2)=2:	°bd	°dd	gdan 'they're fat'

The condition which specifies the sonority index of g is given in (141):

(141) If SI(O_1)=2, and PA(O_1)=9
then SI(O_2)=2

The unattested onset clusters °bd and °dd, although conforming to the condition in (141) are excluded by the filter in (142):

(142)
$$°\overset{O_2}{\begin{bmatrix}[-] & [\geqslant 9]\end{bmatrix}} \quad \overset{O_1}{\begin{bmatrix}[2] & [9]\end{bmatrix}}$$

c) O_1=g

The form in (143) indicates that t is the only segment attested in the O_2 position when O_1=g:

(143) SI(O_2)=1:	tga.ba: 'she flirts Int.'	°kg	°qg
	°bg	°dg	°gg

The condition given in (144) specifies the sonority index of t:

(144) If $SI(O_1)=2$, and $PA(O_1)=5$
then $SI(O_2)=1$

The condition above predicts the attested onset cluster *tg* as well as the unattested ones °*kg* and °*qg*. The latter are excluded by the filter in (145):

(145)
$$\begin{array}{cc} {}^{\circ}O_2 & O_1 \\ | & | \\ \left[[-]\ [\leqslant 5]\right] & \left[[2]\quad [5]\right] \end{array}$$

The scarcity of forms illustrating the onset clusters where $SI(O_1)=2$, and the differences between the conditions on the sonority indices of the segments attested in the O_2 position makes it difficult to draw a generalization on the clusters in question. It may be said, however, that when the [-cont, +tense] segments are in the O_1 position, the absence of segments whose $SI \leqslant 2$ from the O_2 slot follows from the observation that geminates behave like sequences of two segments when they occur in the middle of the syllabification domain (cf. Chap.III., Sect.4.1). That is, if a geminate occurs in the O_1 position, the segment that precedes it must belong to a different syllable (i.e. it cannot be associated to the O_2 position to co-occur with the geminate attested in the O_1 slot).

IV.2.7 The O_2 position with $SI(O_1)=1$

The class of segments whose SI=1 is made up of the voiceless stops t, k, and q. Below, we examine the co-occurrence restrictions that govern the onset constituents O_2 O_1 when any one of these segments is in the O_1 slot.

a) O_1=t

The only segment attested in the O_2 slot when t is in the O_1 slot is q, as the form in (146) below shows:

(146) $SI(O_2)=1$: °tt °kt qtut.ts 'be torn in pieces'

The condition which specifies the sonority index of q is formalized in (147):

(147) If $SI(O_1)=1$, and $PA(O_1)=9$
then $SI(O_2)=1$

The unattested onset clusters indicated in (146) above are excluded by the filter in (148):

(148)
$$\begin{array}{cc} {}^{\circ}O_2 & O_1 \\ \begin{bmatrix}[-] & [>3]\end{bmatrix} & \begin{bmatrix}[1] & [9]\end{bmatrix} \end{array}$$

b) O_1=k

The form in (149) below indicates that t is the only segment that occurs in the O_2 position when the back segment k is under O_1:

(149) $SI(O_2)=1$ tka.Ba: 'she makes do Int.' °kk °qk

The sonority index of the segment attested in the O_2 slot when k occupies the O_1 position is specified by the condition in (150) below:

(150) If $SI(O_1)=1$, and $PA(O_1)=5$
then $SI(O_2)=1$

The unattested onset clusters °kk and °qk are excluded by the filter given in (151):

(151) $\quad °O_2 \qquad\qquad O_1$

$$\begin{bmatrix}[-] & [<9]\end{bmatrix} \quad \begin{bmatrix}[1] & [5]\end{bmatrix}$$

c) $O_1=q$

The form provided in (152) below shows that t is the only segment attested in the O_2 position when $O_1=q$:

(152) $SI(O_2)=1$:	tqar.raB 'get close Int'	°kq	°qq

The condition provided in (153) below indicates the sonority index of t, which is the only segment that occurs in the O_2 position when q is under O_1:

(153) If $SI(O_1)=1$, and $PA(O_1)=3$
then $SI(O_2)=1$

Since the condition in (153) above predicts the unattested clusters °kq and °qq, these are to be ruled out by a proper filter. This filter is formalized in (154):

(154) $\overset{\circ O_2}{\big[[-]\quad[<9]\big]}\ \overset{O_1}{\big[[1]\quad[3]\big]}$

A comparison of the conditions in (147), (150), and (153) indicates that when a voicelss stop is in the O_2 O_2 position, the segments that occur in the O_1 slot have a SI=1. This generalization can be captured by one general condition, as in (155) below:

(155) If $SI(O_1)=1$
then $SI(O_2)=1$

The filters in (151) and (154) can be collapsed into one general filter:

(156) $\overset{\circ O_2}{\big[[-]\quad[<9]\big]}\ \overset{O_1}{\big[[1]\quad[<5]\big]}$

The filter in (156) states that when either <u>k</u> or <u>q</u> is in the O_1 position, the segments <u>k</u> and <u>q</u> are ruled out from the O_2 slot. The condition in (155) above indicates that the dissimilarity index between the O_2 position and the O_1 slot, when the latter is filled with a voiceless stop, is 0.

IV.2.8 <u>Conclusion</u>

The examination of the co-occurrence constraints that govern the O_2 O_1 sequences shows that a large number of such sequences are not attested in ATT although predicted by the sonority conditions on the ATT template. This justifies the large number of filter provided throughout this section to rule out the sequences in question. The table in (157) shows the attested and the unattested (although predicted to be attested by the sonority conditions in (2b)) O_2 O_1 sequences.

IV.3 Conclusion

A comparison of the tables in (75) and (157) indicates that the O_2 O_1 sequences are subject to more constraints (see table (157)) than arë the sequences O_1 R_1. The constrained nature of the onset clusters suggests that the CCV (or O_2 O_1 R_1) syllable type is a highly marked one in ATT (and other natural languages; cf. Clements and keyser (1983), Boukous (1987) and references cited there.

The limited set of clusters where either the O_2 or the O_1 node governs a [-cont, -tense] segment reflects a historical (and may be synchronic) process of spirantization in ATT (and other Berber varieties, cf. Saib (1976), (1986), El Kirat (1987)).

(157) <u>Table 2</u>: Attested and unattested O_2 and O_1 sequences

	j	w	l	f̂	r	m	n	B	ð	z	ẑ	ʒ	ɣ	h	f	θ	s	ŝ	x	ħ	b	d	g	t	k	q
j	−	−																								
w	−	−																								
l	+	+	−	−	−																					
f̂	−	+	−	−	−																					
r	−	−	−	−	−																					
m	+	+	−	+	−	−	+																			
n	+	+	−	−	+	+	−																			
B	−	−	−	+	+	−	+	−	+	+	−	−	−	+												
ð	+	+	−	+	+	+	+	+	−	+	+	+	+	+												
z	+	+	−	+	+	+	+	+	+	−	−	+	+	+												
ẑ	−	+	−	+	−	−	+	+	+	−	−	+	−	+												
ʒ	−	+	−	+	−	+	+	+	+	+	+	−	−	−												
ɣ	−	+	−	+	−	+	+	+	+	+	−	−	−	−												
h	−	+	−	−	−	−	+	−	+	+	+	−	−	−												
f	−	−	−	+	+	−	+	−	+	+	−	+	−	+	−	+	+	+	+	−						
θ	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	−	+	+	+	+						
s	+	+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	−	+	+	+						
ŝ	−	+	−	+	+	+	+	−	+	−	−	+	+	+	+	+	−	−	+	+						
x	+	+	−	+	−	+	+	+	+	+	+	+	−	−	+	+	+	+	−	+						
ħ	+	−	−	+	+	+	+	−	+	+	+	−	−	−	+	+	+	+	−	−						
b	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−			
d	−	+	−	−	+	+	+	+	+	+	−	+	−	+	+	−	+	+	+	+	−	−	−			
g	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	−	−	−	−	−	−	+	−			
t	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+	+	−	−	+	−	+	+
k	−	−	−	−	−	+	+	−	+	−	−	−	−	−	+	+	+	−	−	−	−	−	−	−	−	−
q	−	+	−	+	−	+	+	+	+	−	+	−	−	+	+	−	+	−	−	−	−	−	−	+	−	−

Footnotes to chapter IV

(1) The conditions in (2b) are a formalization of the observation made in the conclusion to chapter III (cf. sect.5 in Chap.III), namely that the onset constituent can host two elements which have the same sonority index, and the segment in the R_1 position can have the same sonority index as the segment(s) in the onset.

(2) The diacritic (°) will be used to mark unattested,- and not necessarily unacceptable- sequences of segments.

(3) Although we use the place of articulation scale proposed in (Boukous (1987), we will be formalizing our filters in a slightly different way from his; the use of SI (sonority index) and PA (place of articulation index, or feature) will be dispensed with here, and the square brackets ([ ]) appearing on the left-of the position to be characterized- will refer to the sonority index of that position, while the ones on the right of the position in question (e.g., O_1) will be referring to the place of articulation feature of that position.

CHAPTER FIVE

SEGMENT ORGANIZATION IN ATT:
THE STRUCTURE OF THE RIME

V.0 Introduction

As stated earlier (cf. Chap.III., Sect.2.1), the ATT syllable template displays five syllable terminal positions. The examination of the structure of the onset was the main purpose of chapter IV. It was stated there that the co-occurrence of segments in the O_1 position with others in the R_1 slot is subject to very few contraints, as compared to that of segments in the O_2 and O_1 slots. The object of the present chapter is the examination of data illustrating (a) the set of segments attested in the R_2 position when R_1 is filled with any segment whose SI$\leqslant$8, and (b) the set of segments attested in the R_3 slot when R_2 is occupied by any segment whose SI$\leqslant$7.

The procedure followed in the analysis of co-occurrence restrictions governing the rime constituent is the same as the one adopted in the preceding chapter. That is, the co-occurrence of a sequence of segments XY in two adjacent syllable terminal positions is examined by taking X as a constant, and Y as a variable. Thus, we will examine the segments that are attested in the R_2 position when a is in the R_1 slot; then we proceed to the examination of segments attested in the R_2 slot when R_1 is filled with a segment with the next lower sonority index, and so on until the R_1 position is occupied by segments with the lowest sonority index (i.e. voiceless stops). The segments that are not attested in a given position, although predicted by the sonority conditions on the ATT syllable template, will be ruled out by proper filters. Finally, it should be pointed out that the investigation undertaken in the present chapter is not concerned with the examination of conditions that may hold on non-adjacent syllable terminal positions i.e., the R_1 and the R_3 slots.

For ease of reference, the sonority scale and the place of articulation scale of ATT are reproduced in (1) and (2) repectively:

(1)

<u>Segments</u>	<u>Sonority indices</u>
a	8
I, U	7
l, r̂, r	6
m, n	5
B, o, z, ẑ, ɣ, ʒ, h	4
f, θ, s, ŝ, x, ħ	3
b, d, g	2
t, k, q	1

(2)

<u>Segments</u>	<u>Place of articulation</u>
b, B, f, m	10
t, d, θ, ð̂, n, r̂	9
s, z, l	8
r	7
ŝ, ẑ	6
k, g, i, j, a	5
x, ɣ, u, w	4
q	3
ħ, ʒ	2
h	1

V.1 Non-branching rimes

It was demonstrated in chapter IV. that all the segments of ATT are attested in the R_1 position (cf. Table 1, p.183). Yet, the data given in (3) below indicate that when the O_1 and the R_2 positions are empty, the native speakers of ATT accept syllables whose nuclei are filled with segments with a SI$\geqslant$2:

(3) Forms	Scansions of native speakers	Gloss
a. aman	a.man	'water'
b. iru	i.ru	'he cried'
ugix	u.gix	'I refused'
c. lmalik	l.ma.lik	'the king'
r̂qaθ	r̂.qaθ	'meet him'
d. mɣa:n	m.ɣa:n	'they've grown up'
nsa:	n.sa:	'blow one's nose'
e. Bða	B.ða	'start'
ðwr̂	ð.wr̂	'go back'
zɣas	z.ɣa:s	'from him'
ẑmʒ	ẑ.mʒ	'gather'
ʒðan	ʒ.ðan	'they went by'
ɣzun	ɣ.zun	'they did right'
hwan	h.wan	'they descended'

f. fsa:	f.sa:	'spread'
θma	θ.ma	'edge'
ṣḄạ:	ṣ̂.Ḅạ:	'be patient'
ŝɣr̂	ŝ.ɣr̂	'be busy'
xɣ̌m	x.ɣ̌m	'work'
ħzn	ħ.zn	'be sad'
g. gda:n	gda:n	'they're fat'
d:hn̈	d:.hn	'butter'
h. tkmmar̂	tkm.mar̂	'she/you finish Int.'
qtut.ts	qtut.ts	'be torn into pieces'

The initial segments in the forms in (3a-g) are judged to be independent syllables by the native speakers of ATT; however, the latter were reluctant as to the possibility of considering the initial segments in the forms in (3h) as independent syllables. This makes it possible to state a condition on the sonority indices of segments attested in the R_1 position when the O_1 and R_2 slots are empty. This condition is formulated as in (4) below:[1]

(4) If $O_1=\emptyset$
then $SI(R_1)\geqslant 2$

Since the object of the present chapter is the examination of conditions that govern adjacent syllable terminal positions in the rime constituent, we will not dwell on the issue of non-branching rimes; rather, we proceed to the analysis of co-occurrence restrictions on segments predicted by the sonority conditions on the ATT template (cf. Chap.IV., Sect.IV.0) to occur in the

R_1 and R_2 positions.

V.2 Branching rimes

The object of the present section is to capture generalizations that govern segment sequences that occur in the R_1 and R_2 slots. The question to be answered here is the following: Given a segment X in the R_1 position, what are all the possible values of a segment Y that is attested in the R_2 position? As stated in the introduction to this chapter, the procedure followed in answering this question consists in listing all the segments predicted to occur in the R_2 slot by the sonority conditions on the syllable template of ATT (cf. Chap.IV., Sect.IV.0). Those that are actually attested in that position will be illustrated by forms from ATT. Those which are not attested, although predicted by the sonority conditions, are excluded by appropriate filters.

V.2.1 The R_2 position with $SI(R_1)=8$

The data below illustrate the co-occurrence of a in the R_1 position with other segments in the R_2 position:

(5) $SI(R_2)=1$:	at.mun 'she'll go with'	ik.ka 'he went by' by'	iq.qa: 'he is studying
$SI(R_2)=2$:	ad.da: 'cliff'	ab.biŝ 'breast'	ag.r̂a 'property'
$SI(R_2)=3$:	af.ð̌is 'hammer'	aθ.mun 'ȟay stack'	as.r̂if 'brother in law'

	aŝ.ran 'muttons'	ax.za:n 'they'll see us'	aħ.ħraj 'act of grinding'
$SI(R_2)=4$:	aB.riđ 'road'	ađ.ma: 'chest'	az.raj 'act of twisting'
	aẑ.ris 'frost'	aɣ.raw 'sleeve'	aʒ.raw 'big rug'
	ah.da 'stop it'		
$SI(R_2)=5$:	am.θa 'like this one Fem.'	an.fa:n 'we'll clean'	
$SI(R_2)=6$:	al.lah 'oh God!'	aŕ.mađ 'act of learning'	°ar
$SI(R_2)=7$:	aj.za:n 'they'll see me'	aw.đaj 'reach me'	

The data in (5) above indicate that any segment whose SI$\leqslant$7 is attested in the R_2 position when a is in the R_1 slot, except the liquid r. This liquid does not occur in the R_2 position at the surface level because of its deletion in that environment (cf. Chap.I., Sect.1.1.2). The condition which specifies the sonority indices of the segments that are attested in the R_2 slot when R_1 is filled with a is given in (6):

(6) If $SI(R_1)=8$

then $SI(R_2)\leqslant 7$

The filter excluding the R_1 R_2 sequence °ar is provided in (7) below:

(7) $$^{\circ}\begin{bmatrix} \overset{R_1}{[8]} & [-] \end{bmatrix} \begin{bmatrix} [-] & \overset{R_2}{[7]} \end{bmatrix}$$

V.2.2 The R_2 position with $SI(R_1)=7$

The sonority scale in (1) above indicates that the class of segments whose SI=7 is made up of the high vocoids I and U. As mentioned earlier (cf. Chap.III., Sect.4.2), when these vocoids occur in the R_1 position, they are realized as high vowels (i and u respectively). Below we examine the segments that are attested in the R_2 position when either of these high vowels is in the R_1 slot.

a) R_1=i

ATT forms such as those given in (8) below exemplify the set of segments that occur in the R_2 position when i is under R_1:

(8) $SI(R_2)=1$:	it.ta: 'he begged'	ik.ka 'he went by'	iq.qa: 'he is studying'
$SI(R_2)=2$:	id.da: 'he's alive'	ib.bz 'he fixed'	ig.ga 'he did'
$SI(R_2)=3$:	if.si 'he untied'	iθ.ma: 'he's thick'	is.wa 'he drank'
	iŝ.ɣr̂ 'he's busy'	ix.san 'bones'	iħ.fa 'it's blunt'
$SI(R_2)=4$:	iB.ð̌a 'he started'	ið̌.r̂a 'he's covered covered'	iz.r̂an 'verses'
	iẑ.mʒ 'he gathered'	iɣ.za 'he dug'	iʒ.ð̌u 'he went by'
	ih.wa 'he went down'		
$SI(R_2)=5$:	im.ɣa: 'he's grown up'	in.du 'he jumped'	

<u>$SI(R_2)=6$:</u>	il.ll.lah 'but Allah'	ir̂.mð̌ 'he learnt'	°ir
<u>$SI(R_2)=7$:</u>	ij.ja:ð̌ 'he dressed	iw.ð̌an 'people	

The same segments that are attested in the R_2 position when R_1=<u>a</u> are also attested in the R_2 slot when <u>i</u> is under R_1. The condition that specifies the range of sonority indices of these segments is provided in (9):

(9) If $SI(R_1)=7$, and $PA(R_1)=5$

then $SI(R_2) \leq 7$

The filter that excludes the unattested R_1 R_2 sequence is formalized as in (10):

(10) $$^{\circ}\overset{R_1}{\left[[7]\quad[5]\right]}\ \overset{R_2}{\left[[-]\quad[7]\right]}$$

The sequence <u>ir</u> is not attested since it is realized as a long vowel <u>e:</u> (cf. Chap.I., Sect.I.1.2).

b) <u>R_1=u</u>

The co-occurrence of <u>u</u> in the R_1 position with other segments in the R_2 slot is illustrated by the data in (11):

(11) <u>$SI(R_2)=1$:</u>	ix.xut.tr̂ ' he skipped away'	uk.ku 'straw'	xuq.zin 'on the dog'
<u>$SI(R_2)=2$:</u>	xub.biŝ 'on the breast'	Bud.dunt 'fat man'	ug.gin 'who did they chose/nominate'

$SI(R_2)=3$:	im.muθ 'he died'	uf.fn 'they're wet'	n:a.qus 'a bell'
	a.qm.muŝ big mouth'	f̂ux 'now'	ruh 'go'
$SI(R_2)=4$:	xuB.rið 'on the road' road'	mu.f̂uð 'person's name'	im.muz.za: 'he went mad'
	ar.ruẑ 'wine'	u.fuɣ 'act of going out'	suʒ.muð 'with a stick'
$SI(R_2)=5$:	um.nn 'they believed'	mun 'go with'	
$SI(R_2)=6$:	aɣ.juf̂ 'donkey'	Bul.lah 'person's name'	
$SI(R_2)=7$:	uj.f̂an 'molars'	uw.θin 'who did they hit'	

From the data in (11) above, it can be concluded that any segment whose SI$\leqslant$7 , except for r, is attested in the R_2 position when u is under R_1. This generalization is captured by the condition in (12) and the filter in (13):

(12) If $SI(R_1)=7$, and $PA(R_1)=4$

then $SI(R_2)\leqslant 7$

(13) $$\overset{\circ R_1}{\begin{bmatrix}[7] & [4]\end{bmatrix}} \quad \overset{R_2}{\begin{bmatrix}[-] & [7]\end{bmatrix}}$$

Given the fact that when anyone of the vocoids a, i, or u is in the R_1 position, the same set of segments is attested in the R_2 slot, the conditions in (6), (10) and (12) can be collapsed into one general condition, as shown in (14) below:

(14) If $SI(R_1) \geqslant 7$
then $SI(R_2) \leqslant 7$

The exclusion of sequences of vowels+r, for which the filters in (7), (10) and (13) were devised, can be effected by one general filter, as in (15):

(15)
$$\underset{\left[[\geqslant 7]\qquad [-]\right]}{{}^{\circ}R_1} \qquad \underset{\left[[-]\qquad [7]\right]}{R_2}$$

The dissimilarity index between the R_1 position and the R_2 slot, when a is under R_1, is 1, whereas in the case of high vowels in the R_1 slot, it is 0.

V.2.3 The R_2 position with $SI(R_1)=6$

The class of segments whose SI=6 is made up of the liquids l, ř, and r. The discussion below brings to light the co-occurrence restrictions that hold on branching rimes when anyone of these liquids is in the R_1 position.

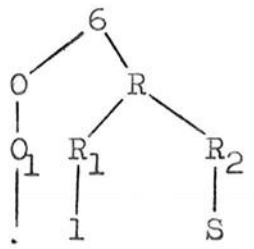
a) R_1=l:

The scarcity of forms with l was explained earlier (cf. Chap.I., Sect.3) where it was said that the liquid ř in ATT corresponds in most cases to l in Arabic loanwords. The data below indicate the set of segments attested in the R_2 position when l is in the R_1 slot:

(16) <u>SI(R$_2$)=1:</u>	ml.lt.tn 'get bored with them'	hl.lk 'hit severely'	ħl.lq 'make up'
<u>SI(R$_2$)=2:</u>	°lb	°ld	°lg
<u>SI(R$_2$)=3:</u>	°lf	ml.lθ 'get bored with them'	ml.ls 'cement'
	xl.lŝ.ŝin 'on the oranges'	ml.lx 'I got bored'	°lħ
<u>SI(R$_2$)=4:</u>	i.ta.lB 'he requested'	θml.lð 'you got bored'	i.ql.lz 'he had a lift'
	°lẑ	ml.lγ 'to joke'	Bl.lʒ 'close'
	°lh		
<u>SI(R$_2$)=5:</u>	lm.la.jn 'millions'	ml.ln 'they got bored'	

The set of segments attested in the R$_2$ position when <u>l</u> is in the R$_1$ slot is given in (17a), and the condition which specifies the range of the sonority indices of these segments is provided in (17b):

(17) a.



b. If SI(R$_1$)=6, and PA(R$_1$)=8 then SI(R$_2$)$\leqslant$ 5

S= t, k, q; θ, s, ŝ, x; B, ð, z, γ, ʒ; m, n.

The filter excluding the unattested R$_1$ R$_2$ sequences is given in (18) below:

(18)
$$
\begin{array}{cc}
{}^{\circ}R_1 & R_2 \\
\left[\,[6] \quad [8]\,\right] &
\left\{\begin{array}{c}
\left[\,[2] \quad [-]\,\right] \\
\left[\,[3] \quad [2]\,\right] \\
\left[\,[3] \quad [10]\,\right] \\
\left[\,[4] \quad [6]\,\right] \\
\left[\,[-] \quad [1]\,\right]
\end{array}\right\}
\end{array}
$$

b) <u>R_1=r̂</u>

The segments attested in the R_2 position when r̂ is in the R_1 slot are exemplified by the data given in (19):

(19)

<u>SI(R_2)=1:</u>	ar̂.r̂t.tid 'bring it back'	r̂k.wa.Bs 'hand guns'	i.r̂q.fiθ 'he hit him'
<u>SI(R_2)=2:</u>	i.r̂d: 'it is deli-	â.r̂b.buʒ 'bread-crumb'	i.r̂g.ðit 'he swallowed it'
<u>SI(R_2)=3:</u>	r̂f.ẑa: 'sunrise'	ðr̂θ 'cover Pl.'	r̂s.r̂uk 'cables'
	r̂ŝ.ho: 'months'	r̂x.Ba: 'news'	r̂ḥ.mu 'heat'
<u>SI(R_2)=4:</u>	r̂B.ni 'building'	r̂ð.ruʒ 'arms' length'	i.r̂z.miθ 'he stuck to him'
	r̂ẑ.wað 'people'	r̂ɣ.ro: 'temptation'	r̂ʒ.ðu 'ennemy'
	r̂h.wa 'air'		
<u>SI(R_2)=5:</u>	r̂m.waẑ 'waves'	a:ḥ.r̂n 'they moved'	

The segments attested in the R_2 slot when R_1=r̂ are those whose SI $\leq$5. This is expressed by the condition given in (20):

(20) If SI(R_1)=6, and PA(R_1)=9

then SI(R_2) $\leqslant$5

c) <u>R_1=r</u>

The co-occurrence of the liquid <u>r</u> in the R_1 position with other segments in the R_2 slot is exemplified by the data below:

(21)

<u>SI(R_2)=1:</u>	zar.rt.tn 'see them (you Pl.,Int.'	°rk	zar.rq 'close Int.'
<u>SI(R_2)=2:</u>	°rb	zar.rd 'have plen plenty of'	zar.rg 'make dirty Int.'
<u>SI(R_2)=3:</u>	çar.rf 'tie Int.'	ẑar.rB 'try Int.'	ar.rs 'slaughter Int.'
	far.rŝ 'spread'	zar.rx 'I see Int'	ð̌ar.rh 'bake Int.'
<u>SI(R_2)=4:</u>	dar.rB 'train Int'	Bar.rð̌ 'cool down Int.'	far.rz 'descern'
	fo:r.rẑ 'watch Int'	far.rɣ 'pour Int.'	zar.rʒ 'saw Int.'
	°rh		
<u>SI(R_2)=5:</u>	θzar.rm 'you see Pl.'	far.rn 'clean'	

The data in (21) above indicate that when <u>r</u> is in the R_1 slot, the segments that occur in the R_2 position are those whose SI $\leqslant$5 except <u>k</u>, <u>b</u>, and <u>h</u>. The range of sonority indices of the attested segments is specified by the condition in (22) below:

(22) If $SI(R_1)=6$, and $PA(R_1)=7$
then $SI(R_2) \leqslant 5$

Since the condition in (22) predicts the unattested syllables °<u>rk</u>, °<u>rb</u>, and °<u>rh</u>, these are ruled out by the filter in (23) below:

(23)
$$\begin{array}{ll} {}^{\circ}R_1 & R_2 \\ \left[[6]\quad[7]\right] & \left\{\begin{array}{l} \left[[2]\quad[10]\right] \\ \left[[1]\quad[\ 5]\right] \\ \left[[-]\quad[\ 1]\right] \end{array}\right\} \end{array}$$

The conditions given in (17b), (20) and (22) -which specify the sonority indices of the segments that are attested in the R_2 position when anyone of the liquids <u>l</u>, <u>r̂</u>, or <u>r</u> is in the R_1 position- can be expressed by one general condition, which is given in (24):

(24) If $SI(R_1)=6$
then $SI(R_2) \leqslant 5$

It can be noted from the condition in (24) that the classes of segments attested in the R_2 slot when a liquid is in the R_1 position are those which have the following sonority indices: 5 (nasals), 4 (voiced fricatives), 3 (voiceless fricatives), 2 (voiced stops), and 1 (voiceless stops). In other words, the dissimilarity index between the

R_2 position and the R_1 slot when the latter is filled with a segment whose SI=6, i.e. liquids, is 1.

V.2.4 The R_2 position with $SI(R_1)=5$

The co-occurence restrictions on the adjacent position positions R_1 R_2 involves the nasals m and n in the R_1 slot with other segments predicted by the conditions on the ATT syllable template to occur in the R_2 position.

a) R_1=m

The ATT forms given below illustrate the set of segments attested in the R_2 position when R_1 is filled with m:

(25)	$SI(R_2)=1$:	mt.tr̂ 'illustrate'	mk.kn 'make sure'	a.mq.qran 'big one'
	$SI(R_2)=2$:	°mb	a.md.du.kr̂ 'friend Mas.'	a.mg.ga.ru 'last one'
	$SI(R_2)=3$:	°mf	ʒum.mθ 'swim you Pl.'	a.ms 'stain'
		a:.mŝ 'wink'	r̂.mx.zn 'government'	a.mḥ.sað̆ 'jealous person'
	$SI(R_2)=4$:	°mB	iḥ.mð̆ 'he thanked'	i.mz 'thumb'
		ix.mẑ 'it's spoilt'	mɣ.ɣr̂: 'die of thir thirst'	iẑ.mʒ 'he gathered'
		a.mh.r̂uç 'ill person'		

Except for the labials b, f, and B, all segments whose SI $\leqslant 4$ are attested in the R_2 position when m is in the R_1

slot. The condition provided in (26) below defines the range of sonority indices of the attested segments:

(26) If $SI(R_1)=5$, and $PA(R_1)=10$

then $SI(R_2) \leqslant 4$

Needless to say that the condition above predicts the attested R_1 R_2 sequences as well as the unattested ones: °<u>mb</u>, °<u>mf</u>, and °<u>mB</u>. The latter are excluded by the filter given in (27):

(27)
$$\begin{array}{cc} {}^{\circ}R_1 & R_2 \\ | & | \\ \left[[5] \quad [10]\right] & \left[[-] \quad [10]\right] \end{array}$$

b) <u>R_1=n</u>

The co-occurrence of <u>n</u> in the R_1 slot with other segments in the R_2 position is illustrated by the data in (28) below:

(28)

<u>$SI(R_2)=1$:</u>	nt.ta 'he/him'	nk.ka 'we went by'	nq.fr̂ 'we're stupid'
<u>$SI(R_2)=2$:</u>	nb.bi 'we pinched'	nd.dz 'we hit'	ng.ga 'we did'
<u>$SI(R_2)=3$:</u>	nf.si 'we untied'	nθ.ma: 'we're fat'	ns.r̂ir̂ 'we washed'
	nŝ.ɣr̂ 'we're busy'	nx.siθ 'we want him'	nħ.ð̌it 'polish it Fem.'
<u>$SI(R_2)=4$:</u>	nB.na 'we built'	nð̌.wr̂ 'we went back'	nz.r̂i 'we twisted'
	ɣa:.nẑ 'over there'	n .zit 'we dug it'	nʒ.ð̌u 'we went by
	nh.na 'we're at peace'		

The generalization whereby any segment whose SI $\leqslant 4$ can occur in the R_2 position when n is under R_1 is captured by the condition in (29):

(29) If $SI(R_1)=5$, and $PA(R_1)=9$
then $SI(R_2) \leqslant 4$

A comparison of the condition in (29) above with that in (26) indicates that these can be collapsed into one general condition, which is formalized in (30) below:

(30) If $SI(R_1)=5$
then $SI(R_2) \leqslant 4$

It can be inferred from the condition above that the dissimilarity index between the R_2 position and the R_1 position, when the latter is filled with a nasal (m or n), is 1. That is, the maxim sonority value that a segment occurring in the R_2 position can have is 4 (i.e., voiced fricatives).

V.2.5 The R_2 position with $SI(R_1)=4$

The class of segments whose SI=4 is made up of the voiced fricatives: B, ð, z, ẑ, ɣ, ʒ, and h. The discussion below centers on the examination of the sets of segments attested in the R_2 position when anyone of these fricatives is in the R_1 slot.

a) R_1=B

ATT forms such as those in (31) below illustrate the set of segments that are attested in the R_2 slot when the labial fricative B is in the R_1 position:

(31) <u>SI(R_2)=1:</u>	Bt.tf̂ 'cancel'	Bk.ks 'wear a belt Int.'	Bq.qŝ 'search'
<u>SI(R_2)=2:</u>	°Bb	Bd.df̂ 'change'	f̂.Bg.ri 'beef'
<u>SI(R_2)=3:</u>	°Bf	ɣf̂.Bθ 'defeat you Pl.'	ix.Bŝ 'he scratched'
	f̂ħ.Bs 'prison'	Bx.ni.qa 'traditional necklace'	ja:.Bħ 'he woṇ'

The sonority indices of the segments attested in the R_2 position when R_1 is filled with B are specified by the condition below:

(32) If SI(R_1)=4, and PA(R_1)=10
then SI(R_2) $\ll 3$

The filter given in (33) below rules out the unattested R_1 R_2 sequences °Bb and °Bf:

(33)
$$^{\circ}\begin{array}{cc} R_1 & R_2 \\ | & | \\ \big[[4]\ [10]\big] & \big[[-]\ [10]\big] \end{array}$$

b) R_1=ð̆

The co-occurrence of ð̆ in the R_1 slot with other segments in the R_2 position is illustrated by the data given in (34) below:

(34) <u>SI(R_2)=1:</u>	a.ʕt.tux 'I'll ferget'	ʕk.kn 'fill up'	ʕq.qf̂ 'wait'
<u>SI(R_2)=2:</u>	ʕb.ba: 'manage	a.ʕd.da:n 'they'll live'	a.ʕg.gx 'I'll do'
<u>SI(R_2)=3:</u>	f̂m.ʕθ 'learn you	a.ʕf 'go in'	ju.ʕs 'it is near'
	wħħ.ʕŝ 'you alone'	f:u.ʕx 'I'm thirsty'	ʕħ.f̂ima 'it's Halima'

The data in (34) above indicate that any segment whose SI ⩽3 can occur in the R_2 position when <u>ʕ</u> is in the R_1 slot. This generalization is captured by the condition in (35) below:

(35) If SI(R_1)=4, and PA(R_1)=9
then SI(R_2) ⩽3

c) <u>R_1=z</u>

The forms provided in (36) below exemplify the set of segments attested in the R_2 position when R_1=z:

(36) <u>SI(R_2)=1:</u>	a.zt.tas 'it'll suit him'	i.zk.ka 'he gave alms'	a.zq.qo: 'big log'
<u>SI(R_2)=2:</u>	a.zb.bo: 'anus'	i.zd.dm 'he's gathering wood'	θa.zg.go:θ 'athorny tree'
<u>SI(R_2)=3:</u>	ja:.zf 'he went on a visit'	°zs	zn.zθ 'sell you Pl.'
	°zŝ	a.ʕa:.zx 'I'll break'	xz.zħ.li 'on Zħli'

The range of the sonority indices of the segments attested in the R_2 position when R_1 is filled with <u>z</u> is specified by the condition provided in (37) below:

(37) If $SI(R_1) = 4$, and $PA(R_1)=8$
then $SI(\dot{R}_2) \ll 3$

The condition in (37) fails to exclude the unattested R_1 R_2 sequences °zs and °zŝ, which is why the filter in (38) is formalized:

(38)
$$\begin{array}{cc} {}^{\circ}R_1 & R_2 \\ | & | \\ \left[[4] \quad [8]\right] & \left[[3] \quad [8 \gg n \gg 6]\right] \end{array}$$

d) <u>R_1=ẑ</u>

The co-occurrence of <u>ẑ</u> in the R_1 position with other segments in the R_2 slot is exemplified by the data in (39):

(39)

<u>SI(R_2)=1:</u>	θḣ.la.ẑt.tn 'you need them'	°ẑk	°ẑq
<u>SI(R_2)=2:</u>	ẑb.bǒ 'pull Int.'	ẑd.di 'my grand-father'	°ẑg
<u>SI(R_2)=3:</u>	ḣla.ẑθ 'need (you Pl.)'	ja:.ẑf 'he's scared'	°ẑs
	°ẑŝ	i.ẑx.ri 'type of plant'	ẑḣ.ḣa 'Jouha'

The sonority indices of the segments occurring in the R_2 position when <u>ẑ</u> is in the R_1 slot are specified by the condition in (40) below:

(40) If SI(R_1)=4, and PA(R_1)=6

then SI(R_2) ≤ 3

The unattested sequences indicated in (39) above are ruled out by the filter provided in (41) below:

(41)
$$\begin{array}{cc} {}^{\circ}R_1 & \\ | & \\ [4] & [6] \end{array} \left\{ \begin{array}{l} \left[\begin{array}{cc} & R_2 \\ & | \\ [3] & [6 \leq n \leq 8] \end{array} \right] \\ \left[\begin{array}{cc} [\leq 2] & [3 \leq n \leq 5] \end{array} \right] \end{array} \right\}$$

e) R_1 = ɣ

The ATT forms given in (42) below illustrate the set of segments that are attested in the R_2 position when R_1 = ɣ:

(42) SI(R_2)=1:	ɣṭ.ṭr̂ 'cause to fall Int.'	°ɣk	°ɣq
SI(R_2)=2:	ɣb.bn 'frustrate Int.'	a.ɣd.du 'very young'	°ɣg
SI(R_2)=3:	sɣf.f̂iθ 'take him by surprise'	na.ɣθ 'get trapped Pl.'	a.ɣs.saf̂ 'jar'
	a.ɣŝ.ŝaŝ 'lazy'	a.θn.ɣx 'I'll kill him'	°ɣħ

The range of the sonority indices of the segments that are attested in the R_2 position when ɣ is in the R_1 slot is specified by the condition in (43):

(43) If SI(R_1)=4, and PA(R_1)=4

then SI(R_2) ≤ 3

The back segments k, g, q, and ħ which do not co-occur with ɣ are excluded from the R_2 position by the filter in (44) below:

(44) $$\begin{array}{cc} {}^{\circ}\overset{R_1}{|} & \overset{R_2}{|} \\ \left[[4] \quad [4]\right] & \left\{\begin{array}{c}\left[[-] \quad [3]\right] \\ \left[[-] \quad [5]\right]\end{array}\right\} \end{array}$$

f) <u>R_1=3</u>

The data in (45) below illustrate the co-occurrence of <u>3</u> in the R_1 position with other segments in the R_2 slot:

(45)

<u>SI(R_2)=1:</u>	3t.ta: 'be late'	3k.ka: '~~use~~-lipstick'	a.3q.qa 'seed'
<u>SI(R_2)=2:</u>	3d.da 'go by Int.'	3b.bz 'press down'	3g.gf̂ 'kneel down Int.'
<u>SI(R_2)=3:</u>	3f.sθ 'go fast'	a.3θ.rus 'male goat'	a.3s.ka.ri 'soldier'
	a.3ŝ.ŝi 'afternoon'	qf̂.3x 'I uprooted'	°3ħ

The condition in (46) below states that the sonority indices of the segments attested in the R_2 position when the R_1 slot is filled with <u>3</u> range from 3 to 1 (voiceless fricatives and voiceless stops, respectively):

(46) If SI(R_1)=4, and PA(R_1)=2
then SI(R_2) $\leq$ 3

The unattested sequence <u>°3ħ</u> is ruled out by the filter formalized in (47):

(47) $$\begin{array}{cc} {}^{\circ}\overset{R_1}{|} & \overset{R_2}{|} \\ \left[[4] \quad [2]\right] & \left[[3] \quad [2]\right] \end{array}$$

g) R_1=h

ATT forms such as those given in (48) below illustrate the co-occurrence of h in the R_1 position with other segments in the R_2 slot:

(48) $SI(R_2)=1$:	ht.tk 'hit severely'	°hk	°hq
$SI(R_2)=2$:	a.hb.buẑ 'provincial	hd.da 'eat grass Int.'	a.hg.ga: 'dog'
$SI(R_2)=3$:	ir̂.hf 'anxious'	ir̂.hθ 'he's exhausted'	°hs
	in.hŝ 'he bit'	ça:.hx 'I hate'	°hħ

The condition on the sonority indices of the segments attested in the R_2 position when R_1=h is given in (49):

(49) If $SI(R_1)=4$, and $PA(R_1)=1$

then $SI(R_2) \leqslant 3$

The filter excluding the unattested R_1 R_2 sequences indicated in (48) above is formalized in (50):

$$(50)\quad {}^{\circ}\begin{array}{c} R_1 \\ \begin{bmatrix} [4] & [1] \end{bmatrix} \end{array} \begin{array}{c} R_2 \\ \left\{ \begin{array}{l} \begin{bmatrix} [3] & [8] \end{bmatrix} \\ \begin{bmatrix} [1] & [3 \leqslant n \leqslant 5] \end{bmatrix} \\ \begin{bmatrix} [3] & [2] \end{bmatrix} \end{array} \right\} \end{array}$$

The conditions given in (32), (35), (37), (40), (43), (46), and (49) state that the segments attested in the R_2 position when a voiced fricative is in the R_1 slot have a SI $\leqslant 3$; this can be stated in one general condition, which is given in (51):

(51) If $SI(R_1)=4$

then $SI(R_2) \leqslant 3$

The condition above shows that the dissimilarity index between the R_2 position and the R_1 slot when the latter is filled with a voiced fricative is 1.

V.2.6 <u>The R_2 position with $SI(R_1)=3$</u>

The sonority scale of ATT (cf. (1) above) assigns the SI 3 to the voiceless fricatives <u>f</u>, <u>θ</u>, <u>s</u>, <u>ŝ</u>, <u>x</u>, and <u>ḥ</u>. the present section seeks to identify the sets of segments attested in the R_2 position when anyone of these fricatives is in the R_1 slot.

a) <u>R_1=f</u>

The data in (52) below illustrate the co-occurrence of <u>f</u> in the R_1 position with other segments in the R_2 slot:

(52) <u>$SI(R_2)=1$:</u>	ft.tḥ 'swim'Int.'	fk.ka: 'think'	a.fq.qus 'pain'
<u>$SI(R_2)=2$:</u>	°fb	fd.da 'finish'	°fg

The condition on the sonority indices of the segments that occur in the R_2 position when <u>f</u> is under R_1 is given in (53):

(53) If $SI(R_1)=3$, and $PA(R_1)=10$

then $SI(R_2) \leqslant 2$

The filter excluding the unattested R_1 R_2 sequences is provided in (54) below:

(54)
$$\overset{\circ R_1}{\overbrace{[[3] \quad [10]]}} \left\{ \overset{R_2}{\overbrace{\begin{matrix} [[-] & [10]] \\ [[2] & [5]] \end{matrix}}} \right\}$$

b) $\underline{R_1=\theta}$

The ATT forms given in (55) below exemplify the segments that occur in the R_2 slot when $\underline{\theta}$ is in the R_1 position:

(55) $\underline{SI(R_2)=1:}$	θt.ta: 'she begged'	θk.ka: 'she stood up'	θq.qa: 'she is studying'
$\underline{SI(R_2)=2:}$	θb.bi 'she pinched'	θd.da: 'she's alive'	θg.ga: 'she's baking'

The data above indicates that any segment with a SI $\leqslant 2$ can occur in the R_2 position when $\underline{\theta}$ is under R_1; the condition provided in (56) below captures this fact:

(56) If $SI(R_1)=3$, and $PA(R_1)=10$

then $SI(R_2) \leqslant 2$

c) $\underline{R_1=s}$

The co-occurrence of $\underline{s}$ in the R_1 position with other segments in the R_2 position is illustrated by the data in (57) below:

(57) $\underline{SI(R_2)=1:}$	st.tin 'sixty'	sk.kiθ 'send him'	sq.qt 'fail Int.'

$SI(R_2)=2$: sb.bB 'trade' | sd.duh 'with the cradle' | a.sg.gn 'they'll do for him'

The condition in (58) below captures the fact that any segment whose SI ≤ 2 can occur in the R_2 position when s is in the R_1 slot:

(58) If $SI(R_1)=3$, and $PA(R_1)=8$
then $SI(R_2) \leq 2$

d) R_1=ŝ

The data given in (59) exemplify the set of segments attested in the R_2 position when ŝ is in the R_1 slot:

(59) $SI(R_2)=1$: ŝt.ta: 'bargain' | ŝk.kx 'I doubt' | f̂3.ŝq 'desire'

$SI(R_2)=2$: ŝb.ba: 'catch' | ŝd.diθ 'tie it' | a.ŝg.gn 'they'll do for you'

The sonority indices of the segments attested in the R_2 position of a branching rime where R_1 is occupied by ŝ range from 2 (voiced stops) to 1 (voiceless stops). This is expressed by the condition in (60):

(60) If $SI(R_1)=3$, and $PA(R_1)=6$
then $SI(R_2) \leq 2$

e) R_1=x

ATT forms such as those in (61) below exemplify the set of segments attested in the R_2 position when x is under R_1:

(61)

SI(R_2)=1:	xt.tŝ 'search'	a.xa.xk.kn 'they'll come by us'	a.xq.qa:n 'they'll tell us Int.'
SI(R_2)=2:	xb.bŝ 'scratch Int.'	xd.dm 'work Int.'	a.xg.gn 'they'll do for us'

The condition in (62) below states that the SI of segments which are attested in the R_2 position when R_1 is filled with x ranges from 2 (i.e. voiced stops) to 1 (voiceless stops):

(62) If SI(R_1)=3, and PA(R_1)=4
then SI(R_2) $\leqslant$2

f) R_1=ħ

The data below illustrate the segments attested in the the R_2 position when ħ is in the R_1 slot:

(63)

SI(R_2)=1:	ħt.tŝ 'cut grass	ħk.kiθ 'polish it'	is.ħq: 'he needs
SI(R_2)=2:	a.ħb.buj 'a boil'	ħd.du 'person's name'	i.ħg.gn 'it coagulates Int.'

The condition below captures the fact that segments whose SI$\leqslant$2 occur in the R_2 position when ħ is under R_1:

(64) If SI(R_1)=3, and PA(R_1)=2
then SI(R_2) $\leqslant$2

To sum up, the behaviour of the [+cont, -voiced] segments is very regular in the sense that when they are in the R_1 position, any segment with a SI$\leqslant$2 can occur in the R_2 position; the only exception is the segments b and g which are not attested in the R_2 slot when f is in the R_1 position. The generalization stated above makes it possible to collapse the conditions specifying the range of sonority indices of the segments attested in the R_2 slot when a voiceless fricative is in the R_1 position, (cf. conditions (53), (56), (58), (60), (62) and (64)), into one general condition which is given in (65) below:

(65) If $SI(R_1)=3$
then $SI(R_2) \leqslant 2$

It is implied in the condition in (65) above that the dissimilarity index between the R_2 position and the R_1 slot when the latter is filled with a voiceless fricative is 1; i.e., voiced stops and voiceless stops are the only segments attested in the R_2 slot of a branching rime where a segment whose SI=3 is under R_1.

V.2.7 The R_2 position with $SI(R_1)=2$

The segments whose SI=2 are the voiced stops b, d and g. Below, we examine the co-occurrence restrictions governing the R_2 position and the R_1 position when the latter is filled with anyone of the segments mentioned above.

a) <u>R_1=b</u>

The ATT forms given in (66) exemplify the segments that are attested in the R_2 slot when R_1 is occupied by b:

(66) $SI(R_2)=1$:	hibbt.tn	rb.bk	lb.bq
	'love them you Pl.'	'your God'	'make do'

The segments attested in the R_2 position when b is under R_1 are: t, k, q. The sonority index of these segments is 1, as shown by the condition in (67) below:

(67) If $SI(R_1)=2$, and $PA(R_1)=10$
then $SI(R_2)=1$

b) <u>R_1=d</u>

The data in (68) exemplify the set of segments attested in the R_2 position when R_1 is filled with d:

(68) $SI(R_2)=1$:	a.dt.ta:n	a.dk.kn	a.dq.qa:n
	'they'll beg (for us)'	'they'll come here'	'they'll read

The condition that specifies the sonority index of the segments attested in the R_2 slot when the R_1 position is occupied by d:

(69) If $SI(R_1)=2$, and $PA(R_1)=9$
then $SI(R_2)=1$

c) <u>R_1=g</u>

The forms provided in (70) illustrate the segments attested in the R_2 position when g is in the R_1 slot:

(70) SI(R_2)=1: tg.gt.tn 'you do the them Int.' i.gk.ka 'that he sent went by' i.gq.qa: 'that he says'

The sonority index of the segments that occur in the R_2 slot when g fills the R_1 slot is specified by the condition below:

(71) If SI(R_1)=2, and PA(R_1)=5
then SI(R_2)=1

Based on the conditions in (67), (69), and (70), we can infer that when a voiced stop is in the R_1 position, the sonority index of segments occurring in the R_2 slot is 1. This generalization makes it possible to group the conditions mentioned above into one general condition, as in (72) below:

(72) If SI(R_1)=2
then SI(R_2)=1

The condition in (72) above implies that the dissimilarity index between the R_2 position and the R_1 slot is 1.

V.2.8 The R_2 position with SI(R_1)=1

The examination of data from ATT reveals that when a segment whose SI=1 is in the R_1 position, the R_2 slot is empty. This generalization is based on the output of the syllabification algorithm of ATT which syllabifies sequences of two segments whose SI=1 (e.g. t and q) either as O_2 O_1 sequences, or as O_1 R_1 sequences, but not as

R_1 R_2 sequences.

The observation made above about the adjacent R_1 R_2 positions makes it possible to state the following condition on the R_2 slot when R_1 is occipied by a segment with 1 as a sonority index. This condition is given in (73) below:

(73) If $SI(R_1)=1$
then $R_2=\emptyset$

The condition in (73) does not specify the sonority index of the R_2 position since the latter is empty when a voiceless stop is under R_1.

V.2.9 Conclusion

The discussion of the co-occurrence restrictions that hold of the R_1 R_2 sequences reveals that they are the only adjacent syllable terminal positions wich conform to the Sonority Sequencing Genealization. (compare tables 1 and 2 to that in (74) below).[2] Compared to O_2 O_1 sequences, the segments in the R_1 R_2 sequences exhibit fewer constraints of co-occurrence among themselves. Yet, a comparison of the table in (74) to table 1 above (Sect. 5.1) shows that the O_1 R_1 sequences are far more regular than are the R_1 R_2 syllables, which confirms the claim whereby the preferred syllable type is the CV (or the O_1 R_1) syllables (cf. Clements and Keyser (1983)).

(74) <u>Table 3</u>: Attested and unattested R_1 R_2 sequences

R_1 \ R_2:	j	w	l	r̂	r	m	n	B	ð	z	ẑ	ʒ	ɣ	h	f	θ	s	ŝ	x	ħ	b	d	g	t	k	q
a	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
i	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
u	+	+	+	+	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
l						+	+	+	+	+	−	+	+	−	−	+	+	+	+	−	−	−	−	+	+	+
r̂						+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
r						+	+	+	+	+	+	+	+	−	+	+	+	+	+	+	−	+	+	+	−	+
m						−	−	−	+	+	+	+	+	+	−	+	+	+	+	+	−	+	+	+	+	+
n						−	−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
B															−	+	+	+	+	+	−	+	+	+	+	+
ð															+	+	+	+	+	+	+	+	+	+	+	+
z															+	+	−	−	+	+	+	+	+	+	+	+
ẑ															+	+	−	−	+	+	+	+	−	+	−	−
ʒ															+	+	+	+	+	−	+	+	+	+	+	+
ɣ															+	+	+	+	+	−	+	+	−	+	−	−
h															+	+	−	+	−	−	+	+	+	+	−	−
f																					−	+	−	+	+	+
θ																					+	+	+	+	+	+
s																					+	+	+	+	+	+
ŝ																					+	+	+	+	+	+
x																					+	+	+	+	+	+
ħ																					+	+	+	+	+	+
b																								+	+	+
d																								+	+	+
g																								+	+	+
t																										
k																										
q																										

V.3 Complex rimes.

The ATT syllable template provides for three syllable terminal positions associated to the R node: R_1 R_2 R_3. The object of the present section is to attempt at illustrating the set of segments attested in the R_3 position when the R_2 slot is filled with a given segment. It will become clear from the discussion below that the R_3 position is associated to a very limited set of segments. For this reason, we will not follow the convention of illustrating the attested and unattested segment sequences by providing forms illustrating the former, and marking the latter as unattested. Instead, we will provide forms that are relevant for the illustration of the segments occurring in the R_3 slot. These segments are the following: o, θ, ŝ, d, and t.

V.3.1 The R_3 position with $SI(R_2)=7$

The high vocoids I and U, whose SI=7, are realized as j and w respectively when they are in a syllable terminal position other than the R_1 slot. Below, we discuss the co-occurrence of these glides in the R_2 position with other segments in the R_3 slot.

a) R_2=j

The forms in (75) below exemplify the segments attested in the R_2 slot when j is under R_2:

(75)	$SI(R_3)=1$:	iw.ŝajt 'he gave it (Masc.) to me'	in.najt 'he told it (Masc.)'
	$SI(R_3)=2$:	iz.rajd 'he saw me'	in.najd 'he told me'
	$SI(R_3)=3$:	ja:ð̌.rajθ 'he lent it (Masc.) to me'	i.ʒð̌.r̂ajθ 'he repaired it (Masc.) for me'

As stated in the introduction to this section, no segments with a $SI>4$ are attested in the R_3 position. The condition that specifies the range of sonority indices of the segments that occur in the R_3 slot when the R_2 position is filled with j is given in (76):

(76) If $SI(R_2)=7$, and $PA(R_2)=5$

then $SI(R_3) \leqslant 3$

Since the condition in (76) predicts the unattested R_2 R_3 sequences: °jk, °jq, °jb, °jg, °jf, °js, °jŝ, °jx, and °<u>jħ</u>, these need to be excluded by an appropriate filter. This filter is given in (77)

(77)
$$\left[\,[7]\ \overset{{}^{\circ}R_2}{|}\ [5]\right] \left\{\begin{array}{l}\left[\,[-]\ \overset{R_3}{|}\ [<9]\right]\\ \left[\,[-]\ \quad\ [>9]\right]\end{array}\right\}$$

b) <u>R_2=w</u>

The forms in (78) below indicate that the segments attested in the R_3 position when <u>w</u> is in the R_2 slot are <u>t</u>, <u>d</u>, and <u>θ</u>:

(78) <u>SI(R_3)=1:</u> θa.ħt.tawt 'piece of cloth' θŝawt 'big pain'

<u>SI(R_3)=2:</u> awd 'bring here'

<u>SI(R_3)=3:</u> θfawθ 'light' θaq.qrafθ 'bag'

The condition provided in (79) below states that the sonority indices of the segments attested in the R_3 slot when <u>w</u> is in the R_2 position range from 3 to 1:

(79) If SI(R_2)=7, and PA(R_2)=4
then SI(R_3) $\leqslant$3

The conditions in (76) and (79) can be collapsed into one general condition which would state that the segments occurring in the R_3 position when a glide <u>j</u> or <u>w</u> is in the R_2 position have a SI $\leqslant$3; this condition is in (80) below:

(80) If $SI(R_2)=7$

then $SI(R_3) \leqslant 3$

Similarly, the filter in (77) above can be made to rule out unattested R_2 R_3 sequences when w (as well as j) is in the R_2 position, as shown in (81) below:

(81)
$$\left[[7] \quad \overset{{}^\circ R_2}{[-]}\right] \left\{ \begin{array}{c} \left[[-] \quad \overset{R_3}{[<9]}\right] \\ \left[[-] \quad [>9]\right] \end{array} \right\}$$

It should be pointed out that the dissimilarity index between the R_3 position and the R_2 slot when the latter is occupied by j or w is a very high one, namely 4.

V.3.2 The R_3 position with $SI(R_2)=6$

The consulted native speakers and the author of the present work were unable to provide any ATT form where the R_2 position contains a liquid (l or r̂, since r is deleted in that position) and the R_3 slot is filled with a given segment. This constraint on the R_3 slot, i.e. that it must be empty when R_2 is filled with a liquid, allows us to formulate the condition in (82) below:

(82) If $SI(R_2)=7$

then $R_3= \emptyset$

The condition in (82) remains true as long as we are dealing with phonotactic constraints at the surface level. **At the underlying level**, the R_3 position can be filled with t or θ when r̂ is in the R_2 slot; yet, sequences of r̂+t or $\hat{f}$+θ undergo a process of assimilation whereby they are fused into the affricate $\hat{c}$ (cf. Chap.I., Sect.I.3).

V.3.3 The R_3 position with $SI(R_2)=5$

The class of segments which have a SI=5 is made up of the nasals m and n. Below, we examine the segments attested in the R_3 position when either of the nasals above is in the R_2 slot.

a) $R_2=m$

The data in (83) below provide instances of R_2 R_3 sequences where m is under R_2:

(83)) $SI(R_3)=1$:	θs.wimt 'you Pl. drank it Fem.'	θz.rimt 'you Pl. saw him/it Masc.'
$SI(R_3)=2$:	θk.kimd 'you Pl. came by'	θu.simd 'you Pl. came by'
$SI(R_3)=3$:	θg.gimθ 'you Pl. did it Masc.'	θw.ŝimθ 'you Pl. gave it Masc.'
$SI(R_3)=4$:	$\hat{f}$mð 'learn you Sing.'	

The condition that specifies the range of sonority indices of the segments attested in the R_3 position when R_2 is filled with m is given in (84) below:

(84)) If $SI(R_2)=5$, and $PA(R_2)=10$

then $SI(R_3) \leqslant 4$

The filter excluding the unattested sequences R_2 R_3, although predicted by the condition in (84) is formalized as in (85):

(85)
$$\overset{\circ R_2}{\begin{bmatrix}[5] & [10]\end{bmatrix}} \overset{R_3}{\begin{Bmatrix}\begin{bmatrix}[-] & [<9]\end{bmatrix}\\ \begin{bmatrix}[-] & [>9]\end{bmatrix}\end{Bmatrix}}$$

b) R_2=n

The forms in (86) below exemplify the set of segments attested in the R_3 position when n is under R_2:

(86) $SI(R_3)=1$:	ˌswint 'they Fem. drank'	wŝint 'they Fem. gave'
$SI(R_3)=2$:	u.sind 'they came here'	k;ind 'they came by'
$SI(R_3)=3$:	u.finθ 'they found it/him Masc.'	swinθ 'they drank it Masc.'

The condition provided in (87) specifies the sonority indices of the segments attested in the R_3 position when the R_2 slot is occupied by n:

(87) If $SI(R_2)=5$, and $PA(R_2)=9$
then $SI(R_3) \leqslant 3$

The filter excluding the unattested R_2 R_3 sequences, where $SI(R_3) \leqslant 3$, is provided in (88):

(88)
$$\overset{\circ R_2}{\begin{bmatrix}[5] & [9]\end{bmatrix}} \overset{R_3}{\begin{Bmatrix}\begin{bmatrix}[-] & [<9]\end{bmatrix}\\ \begin{bmatrix}[-] & [>9]\end{bmatrix}\end{Bmatrix}}$$

V.3.4 The R_3 position with $SI(R_2)=4$

In all the data we were able to elicit, the segment attested in the R_3 position when a voiced fricative (whose SI=4) is in the R_2 slot is the directional particle d (cf. Chap.I., Sect. I.5). This observation is illustrated by the data in (89):

(89)	Forms	Gloss
R_2=B:	qr̂Bd	' turn over (for us)'
R_2=ð̌:	———	
R_2=z:	iw.jazd	''he brought (Sth.) for him'
R_2=ẑ:	iq.r̂aẑd	'he fried (Sth.) for you'
R_2=ɣ:	iz.raɣd	'he saw us (from there)'
R_2=ʒ:	iq.r̂ʒd	'he uprooted (for us)'
R_2=h:	———	

The forms in (89) above clearly show that when B, z, ẑ, ɣ, or ʒ is in the R_2 position, the segment attested in the R_3 slot is d. By contrast, when either ð̌ or h is under R_2, the R_3 position is empty. The generalizations stated above can be expressed by the conditions in (90a) and (90b) below:[3]

(90) a. If $SI(R_2)=4$, and $PA(R_2) \leqslant 8$ and >1
then $SI(R_3)=2$, and $PA(R_3)=9$

b. If $SI(R_2)=4$, and $PA(R_2) > 9$
then $SI(R_3)=2$, and $PA(R_3)=9$

The dissimilarity index between the R_3 position and the R_2 slot when the latter is filled with a voiced fricative is 2. However, since the dissimilarity index simply states a minimum sonority difference between two syllable terminal position, it should be pointed out that in the case of voiced fricatives, there are no segments with a SI=1 attested in the R_3 position, i.e. the only sonority index that a segment occurring in the R_3 position can have when a voiced fricative is in the R_2 slot is 2.

V.3.5 <u>The R_3 position with SI(R_2)=3</u>

The class of segments whose SI=3 is made up of the the voiceless fricatives f, θ, s, ŝ, x, and ḥ. The segments attested in the R_3 position when anyone of these fricatives in under R_2 are illustrated by the data in (91):

(91)	Forms	Gloss
R_2=f:	θas.rift	'sister in law'
	θasrafθ	'hole in the ground'
R_2=s:	twist	'type of dance'
	wŝasθ	'give it (Masc.) to him/her'
R_2=ŝ:	------	
R_2=x:	wŝixt	'I gave it (Fem.)'
	ʒδixθ	'I overcaught him'
	u.rixŝ	'I wrote you (Masc.)'

R_2=ħ: θa.tf.faħt 'apple'

θaf̂.wiħθ 'plank'

R_2=θ: ———

The condition which specifies the range of sonority indices of the segments attested in the R_3 position when f is under R_2 is given in (92):

(92) If $SI(R_2)=3$, and $PA(R_2)=10$
then $SI(R_3) \leqslant 3$

The unattested sequences °fk, °fq; °fb, °fd, °fg, °ff, °fs, °fŝ, °fx, and °fħ , which are predicted by the condition in (92) are ruled out by the filter in (93):

(93)

$$\begin{array}{cc} {}^\circ R_2 & \\ [[3] & [10]] \end{array} \left\{ \begin{array}{cc} R_3 & \\ [[2] & [9]] \\ [[-] & [<9]] \\ [[-] & [>9]] \end{array} \right\}$$

The data above indicate that when s is in the R_2 position, the segments attested in the R_3 slot are t and θ. The condition on the sonority indices of these segments -or more precisely, the range of sonority indices that these segments fall within- is specified by (94):

(94) If $SI(R_2)=3$, and $PA(R_2)=8$
then $SI(R_3) \leqslant 3$

It is obvious that the condition in (94) generates the attested R_2 R_3 sequences: st, ~~as well as~~ the unattested ones °sk, °sq; °sb, °sd, °sg; °sf, °ss, °sŝ, °sx, and °sħ. The latter R_2 R_3 sequences are ruled out by the filter given in (95):

(95)
$$\begin{array}{cc} {}^{\circ}R_2 & R_3 \\ \begin{bmatrix}[3] & & [8]\end{bmatrix} & \left\{\begin{bmatrix}[2] & [\;9] \\ {}[-] & [<9] \\ {}[-] & [>9]\end{bmatrix}\right\}\end{array}$$

The range of sonority indices of the segments attested in the R_3 position when x is under R_2 (i.e. t, θ, and ŝ) is specified by the condition provided in (96):

(96) If $SI(R_2)=3$, and $PA(R_2)=4$
then $SI(R_3) \ll 3$

The unattested R_2 R_3 sequences when R_2=x (i.e. °xk, °xq; °xb, °xd, °xg; °xf, °xs, °xx, and °xħ) are ruled out by the following filter:

(97)
$$\begin{array}{cc} {}^{\circ}R_2 & R_3 \\ \begin{bmatrix}[3] & & [4]\end{bmatrix} & \left\{\begin{bmatrix}[2] & [\;9] \\ {}[-] & [>9] \\ {}[3] & [\;8] \\ {}[-] & [\ll 5]\end{bmatrix}\right\}\end{array}$$

The data provided in (91) indicate that t and θ are the only segments attested in the R_3 position when R_2 is occupied by ħ. The condition in (98) specifies the range sonority indices of t and θ:

(98) If SI(R_2)=3, and PA(R_2)=2
then SI(R_3) $\leqslant 3$

Since the condition in (98) predicts the unattested R_2 R_3 sequences; °ħk, °ħq; °ħb, °ħd, °ħg; °ħf, °ħs, °ħŝ, °ħx, and °ħħ, these are to be ruled out by an appropriate filter. This filter is formalized as in (99):

(99)
$$\begin{array}{ll} {}^{\circ}R_2 & R_3 \\ \left[[3]\quad[2]\right] & \left\{\begin{array}{l}\left[[2]\quad[9]\right]\\ \left[[-]\quad[<9]\right]\\ \left[[-]\quad[>9]\right]\end{array}\right\}\end{array}$$

Finally, the generalization whereby the R_3 position is empty when the R_2 slot is filled with θ or ŝ can be formalized as in (100 and (101)

(100) If SI(R_2)=3, and PA(R_2)=9
then $R_3 = \emptyset$

(101) If SI(R_2)=3, and PA(R_2)=6
then $R_3 = \emptyset$

The discussion above concerning co-occurrence restrictions that govern the R_2 and R_3 adjacent positions shows that when a voiceless fricative occurs in the R_2 position, the R_3 position can be filled with a segment whose SI=3. That is, the two positions (R_2 and R_3) can be occupied by segments with equal sonority indices (i.e. 3). This means that the dissimilarity index between the two positions in question, when R_2 is filled with a voiceless fricative.

V.3.6 The R_3 position with the SI(R_2) 2

In all the forms we were able to elicit in ATT, we were unable -together with the informants consulted in the present work- to provide forms where the R_2 position is filled with a segment whose SI$\leqslant$2 -(i.e. voiced and voiceless stops) and the R_3 slot is occupied by any segment whose SI SI(O_2). This observation about the R_3 position not being filled with any segment when the R_2 position is occupied by voiced or voiceless stops leads us to formulate the condition in (102) to accomodate for the above stated facts:

(102) If SI(R_2)$\leqslant$ 2
then $R_3 = \emptyset$

V.3.7 Conclusion

The discussion above of the co-occurrence of segments in the R_2 R_3 positions has shown that the R_3 slot is a highly constrained syllable terminal position. The segments occurring in that position are very limited in number; these are: o, θ, ŝ, d, and t. This restriction on the position in question arises mainly from the association of morphological material to that position (i.e., the R_3 position), a fact noted by various phonologists to be operative in a number of languages.(cf. Selkirk(1982: 350)).

(103) Table 4: Attested and unattested R_2 R_3 sequences

R_2 \ R_3:	j	w	l	r̂	r	m	n	B	ɣ̸	z	ẑ	ʒ	ɣ	h	f	θ	s	ŝ	x	ħ	b	d	g	t	k	q
j	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	+	-	-
w	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	+	-	-
l	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
r̂	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
m						-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	+	-	+	-	-
n						-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	+	-	-
B								-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
ɣ̸								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
z								-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
ẑ								-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
ʒ								-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
ɣ								-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
h								-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
f															-	+	-	-	-	-	-	-	-	+	-	-
θ															-	-	-	-	-	-	-	-	-	-	-	-
s															-	+	-	-	-	-	-	-	-	+	-	-
ŝ															-	+	-	-	-	-	-	-	-	+	-	-
x															-	+	-	+	-	-	-	-	-	+	-	-
ħ															-	+	-	-	-	-	-	-	-	+	-	-
b																						-	-	[illegible]	-	-
d																						-	-	-	-	-
g																						-	-	-	-	-
t																								-	-	-
k																								-	-	-
q																								-	-	-

V.4 Conclusion

The analysis of co-occurrence restrictions that hold on the rime constituent has shown that sequences R_1 R_2 in an ATT syllable do conform to the sonority sequencing generalization whereby the SI(R_1) SI(R_2), except in the case of glides occurring in the R_2 position following a high vowel in the R_1 slot.

With respect to the R_2 R_3 positions, illustrative data were provided in support of the observation that the R_3 slot can be filled only by a very limited set of segments (cf.V.3. above). As pointed out earlier, this is not a special characteristic of the variety we are dealing with.

Finally, it should be pointed out that the use of sonority indices (as proposed by Selkirk (1984)) and place of articulation indices (following Boukous (1987)) ha allowed us to provide a detailed account of acceptable and unacceptable segment sequences within the syllable in ATT.

Footnotes to chapter V

(1) cf. Boukous (1987: 286) for a different way of formalizing the condition proposed in (4)

(2) It should be pointed out that Boukous (1987) draws the same conclusion regarding the R_1 R_2 sequences.

(3) Regarding the formalization of filters or conditions or conditions adopted in the present analysis, we are not in a position to decide for a 'simplicity metric' whereby a given formalization would be 'simpler' than another possible one.

GENERAL CONCLUSION

The analysis of the phonotactic constraints and the syllable structure of ATT effected in the present work has revealed the superiority of the use of sonority indices (cf. Selkirk (1984)) and place of articulation indices (cf. Boukous (1987)) over distinctive features à la Chomsky and Halle (1968) in capturing generalizations about segment organization. It has also attempted to test a number of claims made by various phonologists regarding segment organization.

It has been shown in the present analysis that one of the major claims about segment organization, namely the Sonority Sequencing Generalization (SSG), is only partially true of ATT, where the onset constituents and the nucleus in a syllable can have the same sonority indices (cf. Chap.III. Sect.4). A corollary result of the present investigation is that it has highlighted some irregularities, exhibited in tables 2 and 4, which are mainly due to historical and may be even synchronic phonological processes to which the ATT variety has been subjected.

The claim concerning the eligibility of all segments for syllabicity whereby any segment -and not only vowels- can function as syllable nuclei has been tested and has proved to be mostly well-founded (cf. El Medlaoui(1985), Boukous (1987)).This, somehow, brings forth a solution to the so long debated issue of the schwa vowel in Berber (cf. Saib (1976b), Chtatou (1982)).

One of the major claims about syllable structure and the markedness theory has also been confirmed in the present work. The regularities of the constraints governing the CV (or O_1 R_1) syllable type clearly show that it is the least marked syllable type in ATT besides a number of natural languages (cf. Clements and Keyser (1983), Boukous (1987) and references cited there). On the other hand, the highly constrained co-occurrence of segments in the O_2 O_1 positions, and in the R_2 R_3 sequences , shows that these positions characterize the most marked syllable types in ATT.(cf. tables 2 and 4).

Finally, some of the major limitations of the analysis undertaken in the present work need to be highlighted. These are mainly consequences of the limited scope of the study (its nature as an (MA or D.E.S. thesis) and the scarcity of works and material on the phonology and morphology of ATT, Tarifiyt and Berber in general. Thus, a number of assumptions had to be made as working solutions, and not as a result of detailed phonological and morphological investigations. A case in point is the syllabification domain we adopted throughout the present analysis, which needs further research to defend it as the appropriate domain over which syllabification rules operate. Another issue which needs to be settled is the relation of the morphological component to the phonological rules and syllabification phenomena. More work is therefore needed. It is hoped that this study will provide the stimulus for further investigation in the topic studied here, and other related issues.

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