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Syllabification and Empty Nuclei in Ath-Sidhar Rifian Berber

FRANÇOIS DELL

AND

OUFAE TANGI

In this article we describe the syllabic structure of Ath-Sidhar Rifian Berber (henceforth ASR), dealing along the way with issues which are of interest for current theories of the syllable: the distribution of geminate consonants, the behavior of the glides and the phonetic properties of schwa. In ASR the maximal syllable is CVC. Schwa (e) is inserted to allow the syllabification of consonant sequences, e.g. /y-wzn/ is realized as **yewzen**. *The behavior of the underlying glides suggests that schwa is the phonetic manifestation of an empty nucleus and that in a CC sequence at the beginning of a word the first C belongs to a rime which does not belong to any syllable. The second half of a geminate which does not precede a vowel must be left unsyllabified. The very short vocoids which occur at the phonetic level in ASR fall into two categories. Some are schwas whereas others are mere transitions between adjacent consonants. Although it is unclear whether the two sorts of vocoids are phonetically distinct in all environments there is no doubt as to their phonological distinctness.*

This article is organized as follows. The first section gives background information about the phonology and morphology of ASR and about our presentation of the data.[1] In section 2 we describe its phonotactics and the distribution of schwa. We then discuss the phonology of the underlying glides and argue that in ASR schwa is the phonetic manifestation of an empty nucleus (section 3). In section 4 we propose a syllabification procedure for ASR. In section 5 we discuss the phonetic manifestations of empty nuclei in ASR.

1. BACKGROUND INFORMATION ON ASR*

The Berber dialect described here is spoken in the village of **bagg°ar** in Morocco. This village belongs to the **aθ siðar** area. It is located about 20 kilometers to the north-west of the city of Nador, in Eastern Rif.

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1. For discussions of nearby dialects with rather similar phonological systems, cf. Chami (1979), Cadi (1981), Chtatou (1982).

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One of us (OT) is a native speaker of that dialect. More information on its morphology and phonology is available in Tangi (1991), henceforth APPB.

In this article all transcriptions not enclosed between slanted lines are phonetic representations given in a "broad" transcription which glosses over the variations in vowel quality which are due to neighboring pharyngeal or pharyngealized consonants and, in the case of schwa, to an adjacent glide or labiovelar. Unless otherwise indicated, the phonetic transcription of a form is meant to represent its pronunciation in isolation.

ASR has the following consonants.

(1)	**p**		**t**		**č**		**k**	**k°**	**q**		
	b		**d**		**ǰ**		**g**	**g°**			
	Φ	**f**	**θ**	**s**	**ʃ**	**ç**			**x**	**ḥ**	
			ð	**z**	**ʒ**				**ʁ**	**ʕ**	**h**
	m		**n**				**ŋ**	**ŋ°**			
	w		**l r**			**y**					

All are underlying segments except for Φ and **ç**, which are realizations of /w/ and /y/. **k°**, **g°**, **ŋ°** are labialized velars. **x** and **ʁ** are uvular fricatives (voiceless and voiced); ḥ and ʕ are pharyngeal fricatives (voiceless and voiced); **h** is a murmured glottal fricative ("voiced **h**"); except for the labialized velars,[2] all consonants allow a contrast between plain and geminate. Geminate consonants are longer than their plain counterparts. Their stricture is steady-state, without any momentary relaxation at the boundary between the first half of the geminate and its second half. They are represented by a sequence of two identical letters. In addition to geminates one also finds at the phonetic level adjacent identical consonants the first of which has a distinct release. That release is the phonetic manifestation of a schwa, cf. section 5.

When a word contains an "emphatic" segment, emphasis is spread over the whole word at the phonetic level. In this article it is irrelevant to know which segment of a morpheme or word is the locus of emphasis at the phonological level. "!" indicates that all the segments in the next morpheme or word are emphatic.

The vowels of ASR are **/a,i,u/** and **schwa,** which we transcribe as **e. i** and **u** are rather short. They sound like French **i** and **u** in unstressed syllables. ASR furthermore possesses the diphthongs **ea** (**[ɛa]**) and **oa**

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2. **ŋ°** and **k°** only appear as geminates; the same is true of **g°** except at the boundary between certain prepositions and certain nouns, cf. APPB: 244, 289, 307.

(**[ɔa]**), which are the phonetic reflexes of /**ir**/ and /**ur**/ in certain environments.[3] There are no length contrasts in vowels at any level of representation.

In ASR, verbs have five stems: 1. perfective affirmative, 2. perfective negative, 3. imperfective affirmative, 4. imperfective negative and 5. aorist, also used as an imperative perfective. For the sake of brevity, the first three will be respectively called 1. perfective, 2. negative and 3. imperfective.

Verbs are inflected for the person, number and gender (henceforth PNG) of their subject. A PNG may be a prefix, a suffix or a combination of both. Here is a list of the PNGs in the conjugation of ASR.

Table 1

/-**ʁ**/	1s
/**θ-...-ð**/	2s
/**y-**/	3ms
/**θ-**/	3fs
/**n-**/	1p
/**θ-...-m**/	2mp
/**θ-...-m-<θ>**/	2fp[4]
/**-n**/	3mp
/**-n-<θ>**/	3fp
/**-θ**/	imper 2p
/**y-...-n**/	participle[5]

Phonetically, /**-m-<θ>**/ and /**-n-<θ>**/ yield [**-nt**].

Nouns distinguish two numbers, singular and plural, two genders, masculine and feminine, and two states, free state and bound state. The distribution of grammatical gender in the lexicon is similar to that found in French or Spanish: grammatical gender correlates with semantic gender in animate nouns and is otherwise idiosyncratic, except in certain cases where gender change is used to form derived nouns, as when the feminine is used as a marker of the diminutive. "State" is a category

3. Certain occurrences of [**a**] likewise derive from /**r**/; /**r**/ is deleted when not immediately followed by a vowel. Nongeminated /**l**/ is realized as [**r**]. On /**r**/ and /**l**/ in ASR, cf. APPB, chap. III, and Dell and Tangi (1991).

4. Angled brackets indicate an extraprosodic consonant, cf. the next section. For a list of the abbreviations used in this article, cf. table 2 below.

5. The so-called participle is actually an impersonal form which occurs only in relative clauses with a relativized subject.

akin to case. A noun appears in its bound state form when it is a subject and follows its verb or when it is the object of a preposition; otherwise it takes its free state form.

Direct and indirect object pronouns will be referred to as clitics.[6] They immediately follow the verb unless it is preceded by a "preverb", in which case they immediately precede it. For instance the 3fs direct object pronoun **t** follows the verb in **ufi-n t** 'they (m) found her', and it precedes the verb in **wa t ufi-n** 'they (m) did not find her'. The class of preverbs includes the analogues of the so-called **wh**-words of English, the negation and certain complementizers.

By "inflected form" we mean a stem and the affixes attached to it, in case there are any. "Inflected form" and "word" will be used as synonyms. The following are words: **!θessʁarið** 'teach impf 2s', from **/θ-ss-!ʁari-ð/**, **θifunasin** 'cows', from **/θ-i-funas-in/**, **fus** 'hand', from **/fus/**. By a phonological phrase we mean an inflected form and the clitics surrounding it, and certain preverbs like the negation marker, the complementizer **að** and the complementizer **i** (relative clauses). **ufi-n t** and **wa t ufi-n** are phonological phrases.

In our transcriptions the boundaries between morphemes are indicated by a hyphen when they are located inside an inflected form. Otherwise they are indicated by a blank. **#** indicates a word edge which is not also the edge of a phonological phrase, and **##** indicates the edge of a phonological phrase.

When we cite a verbal form without giving any indication about its morphological make-up it is a perfective imperative in the second person singular. When we cite a verbal form without indicating which stem it is built on, we assume it is built on the perfective stem. Nouns cited without indication of number are in the singular; those cited without indication of state are in the free state.

If it is necessary to indicate that two morphemes are components of a portmanteau, their glosses will be separated by a colon. For instance the English words **men** and **boys** would normally be glossed as 'man p' and 'boy p', but if the need arises they could be glossed as 'man:p' and 'boy-p'.

We shall use the following abbreviations:

6. For lists of the clitics and their contextual variants, cf. APPB, chap. 1.

Table 2

bs	bound state
dat	dative
dim	diminutive
do	direct object
f	feminine
fs	free state (in nouns) or feminine singular (in verbs and clitics)
imper	imperative
impf	imperfective
m	masculine
neg	negative
p	plural
part	participle
pf	perfective
PNG	verbal agreement marker (for Person Number Gender)
s	singular

2. SYLLABIFICATION IN ASR, A FIRST APPROXIMATION

Our primary purpose in this section is to present the basic facts about the phonotactics of ASR. To this end we introduce a syllabification scheme which is modelled after one already proposed for another dialect of Berber, where any consonant can occur as the nucleus of a syllable.[7] For ASR, however, this syllabification scheme is no more than a convenient expository device, as will become clear later on.

There are no syllabic consonants in ASR.[8] Besides the "full" vowels **a**, **i** and **u**, which belong to the underlying inventory, ASR has a vowel schwa (**e**). Schwa alternates with zero and its occurrences can be predicted from the environment. Here are some examples showing alternations between schwa and zero.

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7. Cf. Dell and Elmedlaoui (1985, 1988), Elmedlaoui (1985).

8. Except, maybe, as a result of a very late process which would blend a schwa and an abutting consonant, cf. APPB: 100.

(2)	a.	**!boaxes**	**!i-boaxs-en**	'grasshopper s / p'
	b.	**a-srem**	**i-serm-an**	'fish s / p'
	c.	**!mezy-en**	**!ye-mzi**	'become small 3mp / 3ms'
	d.	**!ne-mzi**	**!n-mezzi**	'become small pf 1p / impf 1p'
	e.	**θe-xθen**	**θ-xeθn-eð**	'circumcize 3fs / 2s'
	f.	**mun-eʁ**	**ufi-ʁ**	'accompany 1s / find 1s'
	g.	**ye-ʁza**	**i-ʁezr-an**	'river bs,s / bs,p'

The phonetic representations of ASR are subject to the following regularities:

(3) Schwa never occurs (i) immediately before or after a V;
(ii) word-finally;
(iii) word-initially;
(iv) before CV.

(4) Unless it is a geminate a CC sequence cannot occur

(i) word-finally;
(ii) before a C.

Some of these generalizations are only first approximations. Refinements or counterexamples will be mentioned later on.

We shall assume that schwa is epenthetic and that it is inserted in order to syllabify consonants which would otherwise remain unsyllabified. Consider for instance [**ʒebðeʁ**] 'I pulled', whose phonological representation is /**ʒbð-ʁ**/. Our syllabification rules will syllabify this four consonant sequence as a sequence of two syllables, (**ʒb**) and (**ðʁ**), both with a consonant as their nucleus. But at the phonetic level syllabic nuclei must as a rule be vowels in ASR.[9] We assume that in ASR a schwa is inserted in all the (**CC**) syllables. Here is an informal formulation of the insertion rule.

(5) EPEN: $\phi \rightarrow$ **e** / **C__C**$]_\sigma$

The syllabification mechanisms operate in two stages. During the first stage "core syllables" are built. Core syllables must contain a nucleus and may contain an onset.[10] During the second stage certain unsyllabified

9. On vowelless utterances at the phonetic level in ASR, cf. note 21.
10. These are analogous to the core syllables in the references in note 7.

segments are incorporated into the syllables built in the preceding stage. Here is, for example, the beginning of the derivation of [**!inafðen**] 'pancreas, p' (from /**i-!nafð-n**/).

(6) /**!i n a f ð n**/
- a. CS-V **!(i)(n a) f ð n**
- b. CS-C **!(i)(n a) f (ð n)**
- c. CODA **!(i)(n a f)(ð n)**

After EPEN inserts schwa in the last syllable in (6)c, the derivation yields **!(i)(naf)(ðen)**. Core syllabification is effected by two rules, CS-V and CS-C. CS-V first builds core syllables whose nucleus is a vowel (cf. (6a)). Then CS-C uses the consonants which have not yet been syllabified to build core syllables whose nucleus is a consonant (cf. (6b)). Once core syllabification is completed the coda rule incorporates every unsyllabified consonant into a preceding syllable if there is one (cf. (6c)). Let us divide the underlying segments of ASR into two classes: class *v*, which contains **a**, **i** and **u**, and class *c*, which contains all the other segments (among them /**y**/ and /**w**/, which contrast with /**i**/ and /**u**/). In this article we follow Levin (1983, 1985) in assuming that the "skeleton" of each form is a sequence of empty slots represented by the letter X. It is the X slots which are grouped into syllables by the syllabification mechanisms. For the sake of brevity, let V (resp. C) stand for an X which is associated with a melodic unit belonging to class *v* (resp. *c*). The syllabification rules are as follows:

(7) CS-V: $\sigma \longrightarrow$ (Y) V

(8) CS-C: $\sigma \longrightarrow$ (Y) Z
(CS-C applies iteratively from right to left)

Y and Z stand for any unsyllabified X slot, and the parentheses indicate optionality in the standard fashion (cf. Chomsky and Halle 1968). CS-V makes a core syllable out of every V and the preceding X, if there is one. CS-C only takes into consideration those X slots which have not been syllabified by CS-V. Starting from the right edge of the sequence to be syllabified, CS-C makes a core syllable out of every (X)X sequence.

Aside from the distinction between classes *v* and *c* (and aside from the fact that only certain obstruents can be extraprosodic, as we shall see below), the sonority hierarchy seems to play no role in the syllabification of ASR.

CS-V and CS-C can build onsetless syllables. The distribution of these must meet the following condition.

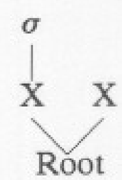
(9) NOHIATUS: Only at the beginning of a syllabification domain can there exist onsetless syllables.[11]

The following condition is furthermore required in order to prevent CS-V and CS-C from building syllables with a V as an onset.

(10) A V cannot be an onset.

Taken together, CS-C and EPEN exclude from the phonetic representations all **CCC** sequences and all word-final **CC** sequences. Both predictions are in contradiction with the special status of geminates in generalization (4), which is exemplified in forms such as **/a-ḥḥram/** 'boy' and **/bbz-ʁ/** 'push in 1s', which are realized as **aḥḥram** and **bbzeʁ**, whereas for the time being CS-C predicts **aḥeḥram** and **bebzeʁ**. Let us represent a geminate as a single melodic unit (a single Root node in the sense of Clements 1985) associated with two adjacent X slots.[12] To account for the behavior of the geminates in core syllabification we posit the following constraint, which forbids the first X in a geminate to be syllabified as an onset.

(11) GEMSYL: *



Here is how CS-C interacts with (11). Consider **θxemmreð** 'hide 2s', from **/θ-xmmr-ð/**. CS-C first syllabifies the rightmost /CC/ sequence, hence **θxmm(rð)**. CS-C then tries to make a core syllable out of the next /CC/ sequence on the left. This would mean putting the **m** on the left in onset position. Since this is forbidden by (11), CS-C syllabifies the next /CC/ sequence available on the left, hence **θ(xm)m(rð)**, which will finally yield **θxemmreð** through the operation of EPEN. For similar reasons CS-C syllabifies **/θ-ndmm/** 'regret 3fs', not as **θ(nd)(mm)**, which

11. The same condition holds in Imdlawn Tashlhiyt Berber, cf. Dell and Elmedlaoui (1988:5).

12. On this conception of quantity, cf. Leben (1980), Prince (1984), Hayes (1986), Schein and Steriade (1986), and references therein.

would yield *θnedmem, but as (θn)(dm)m, hence the correct form **θendemm**.

According to this analysis the ill-formedness of **aḥeḥram** and **bebzeʁ** has to do with the operation of the syllabification rules, not with that of EPEN. Here is why we believe that this analysis is correct.

It is well-known that in a number of languages phonological epenthesis is prevented from breaking up geminates.[13] Some authors have interpreted this property of geminates as a consequence of the general prohibition on the crossing of association lines in autosegmental representations.[14] This interpretation is not without problems (cf. Itô 1989). It becomes even more problematic in view of the facts of Imdlawn Tashlhiyt Berber. In this language, which allows vowelless syllables at the phonetic level, geminates are the only **CC** sequences which cannot form a core syllable. This peculiar behavior of geminates in Imdlawn Tashlhiyt Berber has nothing to do with vowel epenthesis. Adopting (11) enables us to ascribe to the same source the immunity of geminates from epenthesis in various languages and their peculiar behavior with respect to core syllabification in Imdlawn Tashlhiyt Berber.[15] (11) is certainly not the final word on the syllabification of the geminates, but it will suffice for our purposes in this article.[16]

Taken in conjunction with the fact that there are no schwas in the phonological representations and that EPEN is the only rule inserting a vowel, CS-C, (11) and EPEN predict the regularities in (3) and (4). Let us pause to examine these predictions.

Predictions (3i) to (3ii) have no counterexamples. The only data which could be taken as counterexamples to prediction (3iii) are certain cases where an epenthetic schwa appears between a consonant-final proclitic and a verb beginning with **CC**. For instance **/mlmi θ !zri-m-<θ>/** 'when did they (f) see him? (when do3ms see-3fp)?' is pronounced

13. Cf. Kenstowicz and Pyle (1973), Guerssel (1977), Abu-Salim (1980).

14. Cf. Steriade (1982:36) and references therein.

15. For a different account of the behavior of geminates with respect to syllabification in the Imdlawn dialect, cf. the references in note 7 and Elmedlaoui (1988).

16. If we want (11) to prevent epenthesis between the two halves of a geminate in languages with no syllabic consonants (the common cases of "geminate integrity" discussed in the literature) we must assume that (11) has the effect of blocking a phonological rule in case the application of that rule would give rise to a representation which would violate (11): inserting **e** between the two halves of the geminate in **kki** would yield **keki**, a representation which would be syllabified as **(ke)(ki)**, in violation of (11). However there seem to exist phonological rules which give rise to violations of (11): ASR has an early rule which assimilates the bound state prefix **/w-/** to a following **/i/**, turning **/w-i/** into **yi** (cf. APPB: 255). The output of this rule violates (11), if the rule has the effect of spreading **/i/** onto the X slot of the bound state prefix and if it applies to representations which have already undergone syllabification.

mermi !θ e zrint, which is also the realization of **/mlmi θ-!zri-m-<θ>/** 'when did you (fp) see (when see-2fp)?'. Such cases are actually not counterexamples to our account of syllabification in ASR. Rather they are part of the evidence which suggests that in ASR syllabification must operate at least twice. The domain of syllabification must be the word in a first pass, and the phonological phrase in a later pass.[17]

Prediction (4i) has a number of counterexamples, but all of these can be accounted for by considering them as exceptions of a particular kind: when starting its right-to-left iteration in these forms CS-C must not take into consideration the rightmost segment. Consider for instance the noun **/ʒʒhð/** 'strength', which is realized as **[ʒʒehð]**, and not **[ʒʒheð]**.[18] We shall assume that CS-C yields **ʒ(ʒh)ð** because the final **/ð/** carries a special marking which excludes it from the purview of the syllabification mechanisms. This "extraprosodicity" will be indicated by angled brackets: **/ʒʒh<ð>/**.[19] All the extraprosodic segments of ASR are coronal obstruents, and the morphemes ending in an extraprosodic segment all belong to one of the following three classes; (a) a number of nominal radicals, most of them recent loans from Arabic, like **[ʒʒehð]**;[20] (b) all the /CC/ verbal radicals ending in a coronal obstruent, cf. e.g., **θexs** (**/θ-x<s>/**) 'want pf 3fs';[21] (c) a number of grammatical morphemes (suffixes or clitics) whose skeleton consists of a unique slot, like the feminine suffix **/θ/** in nouns, cf., e.g., **/θ-a-funas-<θ>/** 'cow' **[θafunast]**.[22]

Predictions (3iv) and (4ii) have counterexamples for which we have no explanation. We believe these counterexamples show that our analysis needs some local modifications and additions, not a complete overhaul.

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17. It would not do simply to define the *word* in ASR in such a way that it includes proclitics. Lack of space prevents us from explaining why.

18. From a more abstract **/l-ʒhð/**, cf. Dell and Tangi (1991).

19. On extrasyllabicity and on the related notion of *appendix*, cf. Halle and Vergnaud (1980), Steriade (1982), Harris (1983), Kiparsky (1984), Itô (1986), among others.

20. The final consonant is not extraprosodic in the related verb. **/y-ʒhð/** 'he is strong' is pronounced **[ye-ʒheð]** and not *__[i-ʒehð]__*.

21. When they stand alone, such verbs give rise to vowelless utterances: **ʁz** 'dig'. CS-C syllabifies **/ʁ<z>/** as **(ʁ)z**, a representation which does not meet the conditions of EPEN. A similar situation arises with those /CC/ radicals which consist of a geminate, cf., e.g., **kk** 'pass'. CS-C syllabifies **/kk/** as **(k)k** because of (11). The cases mentioned in the present footnote are the only ones where ASR allows vowelless utterances at the phonetic level. ASR has no words comprised of a single **C** slot.

22. A complete list is given in APPB: 65-66. Not all the grammatical morphemes consisting of a coronal obstruent linked to a single skeleton slot are extraprosodic. PNGs **/-ð/** (2s) and **/-θ/** (imper 2p) are not, cf. e.g. **[θbeçseð]** (**/θ-bys-ð/**) 'you girded on (belt)'.

The counterexamples to (3iv) all occur in sequences where a word is followed by a vowel-initial clitic. They are part of the evidence which suggests that in ASR syllabification operates in at least two passes, its domain being the word in the first pass, and the phonological phrase in the second.[23] But we have yet to come up with an account of cyclic syllabification in ASR. In general clitics beginning with a vowel have the same effect as suffixes on the distribution of schwa. Consider for instance the verb /**!zayð**/ 'hurl'. Its final C is syllabified as a coda in **!zayeð** 'imper 2s', but as an onset in **!zayð-eθ** (/**!zayð-θ**/) 'imper 2p' and also in **!zayð as** (/**!zayð as**/) 'imper:2s dat3s', which explains why there is no schwa between **y** and **ð** in these forms. The counterexamples to (3iv) are all cases where a word of the form /ZCCC/ is pronounced **ZCCeC** although it precedes a clitic which begins with a vowel, cf., e.g., /**!mʃð-ʁ as**/ 'comb-1s dat3s', which must be pronounced **!meʃð-eʁ as** and not ***!mʃeð-ʁ as**. In all such cases the word preceding the clitic is pronounced as though the clitic belonged to a different syllabification domain.

In contradiction with (4ii), the /CCCC/ verbal radicals where the middle /CC/ is not a geminate are realized [CeCCC] before a suffix or a clitic, cf., e.g., **behðr-eʁ** 'disgrace 1s'. Aside from /**bhðr**/ all the other such /CCCC/ verbs that we have been able to find are reduplicated biliterals: **seqsq-en** (***sqesq-en**) 'shine 3mp', **i-degdg iθ** (***ye-dgedg iθ**) 'crush 3ms + do3ms'. The other counterexamples to (4)ii are **qundʕa** 'spider' and **ssensreθ** 'chain', where CS-C incorrectly predicts ***qunedʕa** and ***ssnesreθ**.

3. THE PHONOLOGY OF THE GLIDES; EMPTY NUCLEI

Our analysis in the preceding section revolves around the idea that schwa epenthesis is a way of supplying vowels needed for the syllabification of consonants. This idea has been implemented in various ways in the literature. Let us contrast two such implementations, which we shall call the syllabic consonant approach to vowel epenthesis and the empty nucleus approach to vowel epenthesis.[24] The syllabic consonant approach is the one we have adopted above. Rimes comprised of a single C are first built and later on they acquire a vowel through epenthesis: ...CC... ⟶ ...(CC)... ⟶ ...(CeC)... . This is the position taken in

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23. Other data leading to the same conclusion have to do with the behavior of /**r**/ before vowel-initial clitics, cf. Dell and Tangi (1991).

24. We do not intend to imply that syllabic consonants and empty nuclei cannot coexist in a grammar.

Bader (1985), Bader and Kenstowicz (1987), and Kenstowicz (1986). Despite the misnomer, we also include the analyses of Itô (1989) and Broselow (to appear) among those adopting the syllabic consonant approach to vowel epenthesis.[25] On the other hand the empty nucleus approach to vowel epenthesis holds that syllabification first groups consonants around an empty nucleus, which later on acquires feature specifications: ...CC... $\longrightarrow$ ...(CXC)... $\longrightarrow$ ...(CeC)... . This is the position taken by Vergnaud, Halle et al. (1979), Selkirk (1981), Kaye and Lowenstamm (1984), and ter Mors (1985), for instance.

As pointed out in Guerssel (1990), one of the attractive features of the empty nucleus approach is that it can be embedded in a theory with a more limited set of possible syllabic shapes, a theory in which only vocoids can be syllabic nuclei. There are however languages where the stricture against syllabic consonants is relaxed to varying degrees. At the extreme end of the spectrum there exist languages where any consonant may be a nucleus.[26] The syllabic consonant approach seems to hold more promise of bridging the gap between these extreme cases and the others, and this was our main reason for adopting it from the outset.

The upshot of our discussion of the phonology of glides in ASR will be that as far as ASR is concerned it is the empty nucleus approach to vowel epenthesis which should be preferred.[27]

3.1. *The glides: basic regularities*

The glides /**y**/ and /**w**/ must contrast with the high vowels /**i**/ and /**u**/ in the lexical representations of ASR, as will become clear below.[28] In our discussion we shall limit ourselves to stretches which are not longer than phonological phrases.

Let us first survey the surface manifestations of the contrast between glides and high vowels in three contexts, viz. between a consonant and

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25. These analyses make use of moraic representations of the sort advocated in Hyman (1985), McCarthy and Prince (1986) and Hayes (1989). Nonetheless they are similar to those by Bader and Kenstowicz in that they also involve constructing vowelless prosodic constituents which are subsequently fleshed out by vowel epenthesis.

26. Cf. the works cited in note 8 and references therein.

27. Guerssel (1990) proposes for three dialects of Berber an analysis which makes use of empty nuclei, but in a theoretical framework quite different from that adopted in the references above and in the present article.

28. Bynon (1974) has shown that vowels and semivowels contrast at the underlying level in the Ayt Hadiddu of Imilchil (central Morocco), and Guerssel (1986) has done the same for the Ait Seghrouchen dialect.

the left or right end of a radical, and between two consonants. Our examples will be drawn from the morphology of verbs, which offers a richer range of possibilities than that of nouns. In order to make the alternations between schwa and zero as conspicuous as possible our transcriptions gloss over the contextual variations in the vowel quality of schwa. These variations will be discussed later on.

The forms in the table below are (I) imper 2s, (II) pf 3fs, (III) pf 2mp, (IV) pf 3ms, (V) part. The verb in line a is given for the sake of comparison. Since there are no verbal prefixes ending in a vowel the columns I to III exhaust the range of contexts which are relevant for the realization of the first segment in a verbal radical. The forms in columns IV and V will become relevant later on.[29]

(12)

		I	II	III	IV	V
		/√/	/θ-√/	/θ-√-m/	/y-√/	/y-√-n/
a.	/xzn/	**xzen**	**θe-xzen**	**θ-xezn-em**	**ye-xzen**	**i-xezn-en**
b.	/wzn/	**wzen**	**θe-wzen**	**θ-wezn-em**	**ye-wzen**	**i-wezn-en**
b′.	/uðf/	**uðef**	**θ-uðef**	**θ-uðf-em**	**y-uðef**	**y-uðf-en**
c.	/yma/	**yma**	**θe-yma**	**θe-yma-m**	**ye-yma**	**ye-yma-n**
c′.	/ira/	**ira**	**θ-ira**	**θ-ira-m**	**y-ira**	**y-ira-n** [30]
d.	/wsʕ/	**Φseʕ**	**θe-Φseʕ**	**θ-wesʕ-em**	**ye-Φseʕ**	**i-wesʕ-en**

When occurring word-initially before a consonant the underlying contrast between glides and vowels surfaces directly, as illustrated by the forms in (12–I). This is the only context where glides and high vowels contrast at the phonetic level in ASR. Elsewhere in the phonetic representations, a glide always occurs adjacent to a vowel, whereas vowel sequences are prohibited.

The phonetic contrast between glides and high vowels preceding a **C** at the beginning of a word can be observed at the beginning of an utterance as well as after a preceding word. In this environment glides

29. Here are the meanings of the verbs in (12): (a) 'keep', (b) 'weigh', (b′) 'enter', (c) 'grow', (c′) 'play', (d) 'be abundant'. Since the so-called participle is a form which occurs only in relative clauses the forms in V cannot occur utterance-initially. Besides being citation forms, the forms given in column V also occur when the preceding word ends in a consonant. For instance, item V-a also occurs in **wenni i t ixeznen** 'the one who kept her (the:one who do3fs keep-part)'.

30. From a more abstract /**ilr**/, cf. note 3.

do not sound shorter than the corresponding high vowels, but whereas aperture remains unvarying throughout the emission of the high vowels it gives the impression of decreasing slightly towards the end of the articulation of the glides. Another difference between words beginning with **uC** or **iC** and words beginning with **wC** or **yC** is that at the beginning of an utterance the former, but not the latter, may begin with a glottal stop.

In certain contexts a glide preceding a voiceless coronal obstruent is realized as the corresponding voiceless fricative: **w** becomes **Φ** and **y** becomes **ç**. The alternation involving **w** is illustrated in (12d) and that involving **y** is exemplified below in (13c).[31]

The forms in the table below are the analogues of those in (12). They illustrate the contrast between glides and high vowels in the environment /C__C/ where both consonants belong to the same morpheme. As in the table above, the information in columns IV and V is not relevant for the time being.[32]

(13)		I	II	III	IV	V
		/√/	/θ-√/	/θ-√-m/	/y-√/	/y-√-n/
a.	/xzn/	**xzen**	**θe-xzen**	**θ-xezn-em**	**ye-xzen**	**i-xezn-en**
b.	/zwʁ/	**zweʁ**	**θe-zweʁ**	**θ-zewʁ-em**	**ye-zweʁ**	**i-zewʁ-en**
b′.	/mun/	**mun**	**θ-mun**	**θ-mun-em**	**i-mun**	**i-mun-en**
c.	/bys/	**byes**	**θe-byes**	**θ-beçs-em**	**ye-byes**	**i-beçs-en**
c′.	/ʕiʃ/	**ʕiʃ**	**θ-ʕiʃ**	**θ-ʕiʃ-em**	**i-ʕiʃ**	**i-ʕiʃ-en**

Finally, there are forms illustrating the realizations of glides and high vowels at the end of a radical. The forms in the table below are (I) imper 2p, (II) imper 2s + do3ms, (III) imper 2s + dat3s, (IV) pf 3fs. For the sake of comparison, we give in lines a and a′ verbs ending respectively in a consonant and in a vowel.[33] Since there are no verbal suffixes beginning with a vowel the four columns in (14) exhaust the range of contexts relevant for the realisation of a radical-final segment.

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31. On the devoicing of **w** and **y** cf. APPB:179ss. The devoicing occurs after a full vowel as well as after schwa, cf. e.g. **!θaʁ ʁ raΦt** 'handle, dim'. (**/θ-a-!ʁ ʁ raw-<θ>/**), **içsan** 'horses' (**/i-ys-an/**).

32. Here are the meanings of the forms in (13): (a) 'keep', (b) 'redden', (b′) 'accompany', (c) 'gird on', (c′) 'live'.

33. The verbs in (14) have the following meanings: (a) 'rub', (a′) 'begin', (b) 'snap', (b′) 'overtake', (c) 'untie', (c′) 'take'.

(14)		I	II	III	IV
		/√-θ/	/√#θ/	/√#as/	/θ-√##/
a.	/ðhn/	**ðehn-eθ**	**ðehn iθ**	**ðehn as**	**θe-ðhen**
a′.	/bða/	**bða-θ**	**bða θ**	**bða y as**	**θe-bða**
b.	/!qðw/	**!qeðw-eθ**	**!qeðw iθ**	**!qeðw as**	**!θe-qðu**
b′.	/ʕðu/	**ʕðu-θ**	**ʕðu θ**	**ʕðu y as**	**θe-ʕðu**
c.	/fsy/	**fesy-eθ**	**fesy iθ**	**fesy as**	**θe-fsi**
c′.	/ysi/	**çsi-θ**	**çsi θ**	**çsi y as**	**θe-çsi**

The forms in each column illustrate the following regularity about the behavior of radical-final glides: (I) like other consonants at the end of a verbal radical, glides are syllabified together with the initial consonant of a suffix;[34] (II) when immediately following a consonant-final radical, second and third person direct object clitics begin with a protective /**i**/, and the forms in II-b,c exemplify the occurrence of this protective /**i**/ after radicals ending in a glide; (III) an epenthetic yod occurs between a vowel-initial clitic and a radical ending in a vowel,[35] but not one ending in a glide; (IV) the contrast between glides and high vowels is neutralized at the end of a phonological phrase: in that context a glide is realized as the corresponding high vowel if the preceding segment is a consonant.[36]

The analysis in section 2 accounts for most of the data presented above.[37] If /**y**/ and /**w**/ count as instances of **C** for the purposes of the rules and constraints in section 2, their distribution should be no different from that predicted for any other segment counting as a **C**. For instance the data above illustrates the predicted phonetic contrast between **CVC** sequences and sequences of the form **CeGC** and **CGeC** (**G** a glide), and the fact that the distribution of the latter is as predicted by the right-to-left operation of CS-C.

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34. The phonological make-up of suffixes is such that there does not exist any suffix whose initial consonant is an onset.

35. Yod is inserted between vowels in other contexts, for instance between a noun and a demonstrative clitic: **θara y a** 'this spring', **anu y a** 'this well', **ifri y a** 'this cave'.

36. That consonant may be a glide, cf., e.g., **awy-eθ** (/**awy-θ**/) 'take away, imper 2p', **awi** /**awy**/ 'take away. imper 2s'.

37. It only fails to account for cases (14)IV-b,c and for those cases where the prefix /**y-**/ is realized as [**i**] in columns IV and V of (12) and (13). These cases will be taken up later in this section.

Glides can be geminate like any other **C**. Contrast **ayaz** ‘man’ and **ayyaw** ‘nephew’, **θawač** ‘word, dim’ and **!θawwaθ** ‘door’. Like other geminate **C**s, geminate glides can occur immediately before another **C**, cf. e.g., **ayyraw** ‘council’, **!θawwraxt** (**/θ-a-!wwraʁ-<θ>/**) ‘the yellow one, f’. There exist phonological phrases ending in a geminate glide, cf. **ye-sʁuyy** (**/y-sʁuyy/**) ‘shout 3ms’.

The data presented above illustrate the different behavior of glides and high vowels in various sequences of segments which arise from the concatenation of morphemes. Glides and high vowels also behave differently with respect to ablaut processes.[38]

First, only underlying vowels participate in morphological alternations involving aperture, lip rounding and frontness. On the one hand, if a verbal radical begins with /**u**/ in the perfective stem, it begins as a rule with /**a**/ in the aorist and with /**i**/ in the imperfective negative. Radical-initial /**w**/ does not show any alternations. This is exemplified in (15) below with the verbs in (12b,b′). The forms are all 3ms: (I) pf, (II) aor, (III) impf neg.

(15)		I	II	III	
a.	**/uðf/**	**y-uðef**	**y-aðef**	**i-t-iðef**	‘enter’
b.	**/wzn/**	**ye-wzen**	**ye-wzen**	**i-wezzen**	‘weigh’

On the other hand verbal radicals ending in /**a**/ regularly end in a front high vocoid in the negative, and this vocoid is /**i**/, not /**y**/. For instance the perfective negative of /**bða**/ ‘begin’ (cf. (14a′)) is **ye-bði** in the 3ms and **bði-ʁ** (not *beðy-eʁ) in the 1s.

Second, /**XCC**/ verbs (**X** a **C** or a **V**) have perfective negative stems of the form /**XCiC**/; glides, not high vowels, count as instances of **C** for this generalization. The perfective negative stems of the verbs in (13a,b) and (14b) are respectively **xzin**, **zwiʁ** and **!qðiw** whereas those of the verbs in (13b′) and (14b′) are **mun** and **ʕðu**.

Let us now turn to the implications of the contrast between underlying high vowels and glides for our syllabification procedure.

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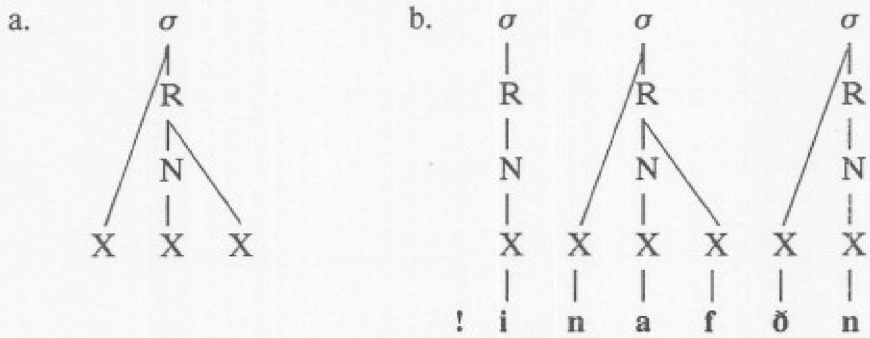
38. The difference was already pointed out by Basset (1946:34), who was trying to establish a pandialectal phonemic inventory for Berber.

3.2. Empty nuclei

Following Levin (1985) and references therein, we take **CVC** syllables to be as in (16a). The syllabified string **!(i)(naf)(ðn)** in (6c) is only a convenient shorthand for the structure displayed in (16b).

(16)



Consider now the derivation of **θewzen** from **/θ-wzn/** (cf. (12II-b) and that of **θuðef** from **/θ-uðf/** (cf. (12II-b′)). CS-V and CS-C yield the representations **(θw)(zn)** and **(θu)(ðf)**, which are displayed below.

(17)

When rule EPEN applies to these representations, it should operate in the first syllable in (17a) but not in that in (17b). How does our analysis ensure that this will indeed be the case?

Let us go back to the formulation of EPEN in (5). As explained in the paragraph between (6) and (7), in (5) a capital **C** represents an X slot linked to a segment which belongs to class *c*. **/θ/** and **/w/** belong to class *c*, but not **/u/**. Hence EPEN must operate in the first syllable in

(17a) but not in that in (17b). But how is the membership of underlying segments in classes *c* and *v* represented in lexical representations?

Let us assume that /**w**/ and /**u**/ are characterized by the same set of feature specifications, and similarly for /**y**/ and /**i**/. Let us furthermore assume, adopting a proposal in Guerssel (1986), that the difference between the *v* segments and the *c* segments is that the former, but not the latter, are already associated with a nucleus node in the lexical representations.[39] Let **U** stand for the feature bundle [-cons, +high, +labial...]. In the lexical representations /**u**/ stands for **U** associated with an N node, whereas /**w**/ stands for **U** without any associated syllabic structure:

```
(18)         N
             |
     /u/:    U                  /w/:   U
```

Similarly, if **I** stands for the feature bundle [-cons, +high, -labial...], /**i**/ represents **I** with an attached N node and /**y**/ stands for a bare **I**.

We now run into a problem when we consider how EPEN operates in the first syllables of (17a) and (17b). In these representations the trees **(θw)** and **(θu)** are actually two occurrences of the same object: in order to build the syllable **(θw)** in (17a), CS-C has associated an N node to /**w**/ (i.e. to a bare **U**), thereby changing it into /**u**/.

This problem hinges on the assumption that high vowels and glides have identical feature content and differ only in prosodic structure.[40] Why not simply abandon that assumption? For instance Hyman (1985:77ff) and Hayes (1989:300ff) have suggested that glides may in some cases be [+consonantal] whereas vowels are [-consonantal]. If we follow this tack and assume that in ASR the underlying glides are [+cons], rule EPEN can now discriminate between /**w**/ and /**u**/ in (17). But a deeper problem remains, one not related to our assumption that in lexical representations glides and high vowels are characterized by the same set of feature specifications. As formulated in (5), EPEN makes crucial reference to the lexical difference between *v* and *c*, a difference already exploited by CS-C and (10). This redundancy defeats the purpose of our analysis, which is to have syllabification pave the way for epenthesis.[41]

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39. In Guerssel's proposal the preassociated node is a rime node.

40. The problem would remain, *mutatis mutandis,* if we adopted moraic representations. For instance, it carries over to the analyses of vowel epenthesis developed in Itô (1989) and in Broselow (to appear).

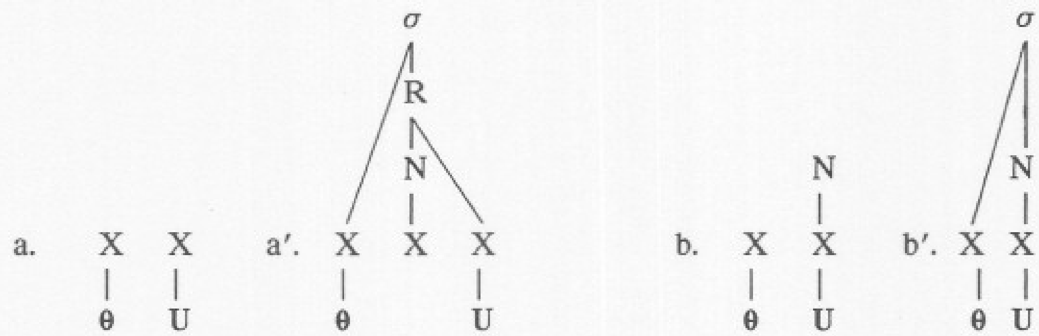
41. (5) is liable to the criticisms commonly levelled at unconstrained epenthesis rules, cf.

Our problems disappear if we adopt a different view of CS-C. Let us suppose that instead of creating rimes with a **C** as a nucleus CS-C creates rimes with an empty nucleus. A rime with an empty nucleus is a rime whose N node dominates an X slot which is not associated with any feature specifications.

(19) CS-C: (Y) Z $\rightarrow$ $[_{\sigma}\ (Y)\ [_{R}\ X\ Z\ ]\ ]$

The input to the syllabification process in (17a) and (17b) is displayed below in (20a) and (20b), and the corresponding representations after CS-C has applied are displayed in (20a′) and (20b′).

(20)



(20a′) will later on be subject to the default schwa rule. This rule associates to any empty nucleus the feature specifications characteristic of schwa.

The parentheses around Y in (8) and in (19) imply that an orphan consonant at the beginning of a syllabification domain becomes incorporated into an onsetless syllable with an empty nucleus: **/bða/** 'begin' becomes **b(ða)** by CS-V and **(Øb)(ða)** by CS-C. But no schwa appears before **b** at the beginning of a phonological phrase. Like that of Parisian French, the schwa of ASR can only occur with a consonant on both sides. The impossibility of schwa in the environment ##—CCV may be interpreted as a sign that CS-C cannot create onsetless syllables, but the behavior of the prefixal glides shows otherwise, as we shall now see.

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e.g. Kaye and Lowenstamm (1984), and Itô (1989). In all the works we have cited as adopting the syllabic consonant approach to vowel epenthesis, including Itô (1989), the status of the epenthesis mechanism strikes us as rather murky.

The prefixal glides behave differently from other morpheme-initial glides. The situation is summarized in the table below.[42]

(21)		I		II	
a.	#–V	**!yaʒið**	**waʒeb**	**y-iʁra**	**w-aman**
b.	#–CC	**yemma**	**wečma**	**ye-xzen**	**!we-zru**
c.	#–CV	**yma**	**!wða-n**	**i-mun**	**!u-ða**

I illustrates the behavior of the initial glides which are not prefixes and II illustrates that of the prefixal ones. **/y-/** occurs in 3ms forms and in participles; **/w-/** is the bound state prefix.[43] Like the other morpheme-initial glides these prefixes are realized as glides before **V** and before **CC** (cf. (21a,b)). But whereas morpheme-initial glides are normally realized as glides when they precede a **CV** sequence (cf. (21I-c)) prefixes **/y-/** and **/w-/** are realized as vowels in that environment (cf. (21II-c)).[44]

The facts in (21II) remind one of another fact that we have yet to account for: at the end of a phonological phrase a glide is realized as the corresponding high vowel if the preceding segment is a C (cf. (14IV-b,c)). For instance **/θ-fsy##/** is pronounced **θe-fsi**, whereas our analysis presently predicts **θe-fsey**. Sequences **ey** and **ew** cannot occur word-finally, but **ay, aw, uy** and **iw** can, cf., e.g., **ifuray** 'wire netting', **!aʁrraw** 'handle', **ye-t-buhruy** 'become mad, impf 3ms', **!ye-ndiw** 'jump, neg 3ms'.

When a morpheme-final glide is preceded by an empty nucleus, the rule below deletes its associated X slot and reassociates its features to the preceding slot.[45]

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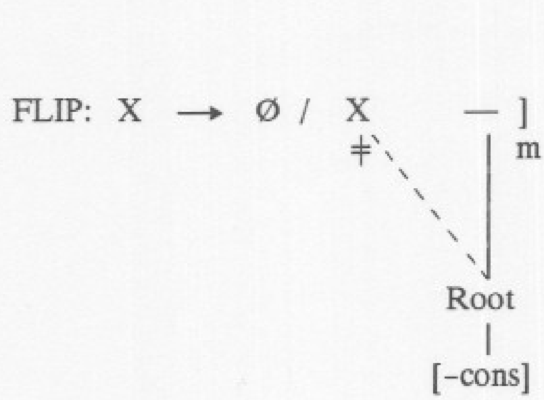
42. Here are the meanings of the forms in each line (from left to right): line a: 'rooster'; 'answer'; 'be precious 3ms'; 'water bs'. Line b: 'mother'; 'sister'; 'keep 3ms'; 'stone bs'. Line c: 'grow'; 'fall 3mp'; 'accompany 3ms'; 'foot bs'.

43. For a detailed account of the morphology and phonology of the bound state in ASR, cf. APPB: 243–79. The bound state prefix also has a variant **/y-/**, whose phonological behavior is in every respect identical with that of the verbal prefix **/y-/**, cf. (2g). Prefixal glides are always word-initial.

44. Since bound forms are always governed by a preceding word the contrast between the bound state prefix and the other morpheme-initial glides cannot be observed at the beginning of an utterance. The **/w/**-initial forms in (21c) are found to contrast after a consonant, as in the following utterances: **mermi x as !wða-n** 'when did they fall on him?' (from **/mlmi x as !wða-n/** when upon dat3s fall-3mp), and **!y-arrz as !u-ða** 'he broke his foot' (from **/y-!rrz as w-!ðar/** 3ms-break dat3s bs-foot).

45. We are assuming that **/y/** and **/w/** are the only consonants which are [−cons], i.e. we are taking **h** to be [+cons].

(22)



The crossed out association line beneath X indicates that X has no associated feature specifications. Consider **/y-sw/** 'drink aor 3ms',[46] where the first glide is a prefix and the second, a phrase-final postconsonantal one. CS-C yields **(Øy)(sØw)**, whence the correct **isu** by FLIP. The derivation of the initial vowel relies on the assumption that CS-C can create onsetless syllables. It is this assumption which allows us to use the same mechanism to account for the vocalization of glides in both contexts.

(22) implies that glides do not differ in feature content from the corresponding high vowels. It correctly predicts the inexistence of any morpheme-final occurrences of **ey** and **ew**. If FLIP were not restricted to operate only at the end of morphemes, it would incorrectly neutralize the contrast between **i** and **ey** and that between **u** and **ew** in all environments, cf., e.g., (12II) and (13III).

Before moving on we must pause to dismiss an attractive alternative to FLIP which is suggested by the realization of schwa before a glide. Let us first dwell on certain variants of schwa not recorded in our transcriptions. When adjacent to a glide schwa becomes homorganic with that glide.

When the glide precedes schwa, schwa is pronounced as a high lax vowel close to that in Eng. **fit** and **foot**. In this context schwa remains phonetically distinct from the realizations of **/i/** and **/u/**. Here are a few pairs exemplifying the phonetic contrast between **Ge** sequences and **/GV/** sequences where **/G/** and **/V/** are homorganic. **ye** vs. **yi**: **ne-byes** (**/n-bys/**) 'gird on 1p' vs. **ne-byis** (**/n-byis/**) 'id. neg 1p'; **uðay-en** (**/uðay-n/**) 'Jewish men' vs. **θ-uðay-in** (**/θ-uðay-in/**) 'Jewish women'; **se-ny-eθ** (**/s-ny-θ/**) 'cause to go up, imper 2p' vs. **se-ny iθ** (**/s-ny iθ/**) 'cause to go up, imper:2s do3ms'; **ye-ʃʃ** (**/y-ʃʃ/**) 'eat aor 3ms' vs. **y-iʃʃ** (**/y-iʃʃ/**) 'horn bs'. **we** vs. **wu**: **a-wessa** (**/a-wssr/**) 'old man' vs. **w-ussan** (**/w-ussan/**) 'days bs'.

When the glide follows schwa, on the other hand, the contrast between schwa and the high vowels is neutralized. **ey** and **ew** are

46. Cf. e.g., **sw-en** 'drink aor 3mp', from **/sw-n/**.

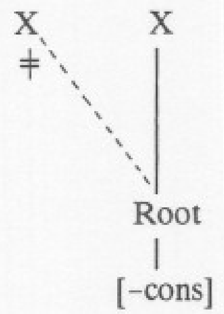
pronounced [**iy**] and [**uw**].[47] Our transcriptions will continue to gloss over this fact, but the substitution should be made throughout. For instance forms (12II-b,c) and (12IV-b,c) are actually pronounced **θuwzen**, **θiyma**, **yuwzen** and **yiyma**. This assimilation also affects schwas which occur between a proclitic and a verb beginning with a **CC** sequence, e.g., that which appears before the verb in **wa θ e wzinent** 'they (f) did not weigh him', from /**wa θ wzin-m-θ**/ (neg do3ms weigh:neg-3fp), which is homophonous with /**wa θ-wzin-m-θ**/ 'you (fp) did not weigh' (neg weigh:neg-2fp).

The table below lists all the homosyllabic sequences of a glide and a vowel which contrast at the phonetic level in ASR.

(23)	GV:	**ya**	**yi**	**ye**	**yu**	VG:	**ay**	**iy**	**uy**
		wa	**wi**	**we**	**wu**		**aw**	**iw**	**uw**

Here is the rule which is needed to account for the assimilation of schwa to a following glide.

(24) SPREAD:



The rule spreads a glide onto a preceding empty slot.[48] SPREAD is triggered by geminate glides as well as by plain ones. It operates for instance in **zeyya** (/**zeyyr**/) 'tighten', **weyyraw** (/**w-yyraw**/) 'council bs', **!θewwaθ** (/**θ-!wwar-<θ>**/) 'door bs' and **!θewwraxt** (/**θ-!wwraʁ-<θ>**/) 'the yellow one, bs f'. The rule must require that the preceding slot be empty, otherwise it would incorrectly change **Vy** and **Vw** into **iy** and **uw** when **V** is a full vowel. It is bled by the glide devoicing rule mentioned in the text below (12), which turns glides into [+cons] segments. The first vowel in **ne-Φsa** 'grow old 1p' (/**n-wsr**/) does not become homophonous with that in **n-usa** 'come 1p' (/n-usa/), neither does that in

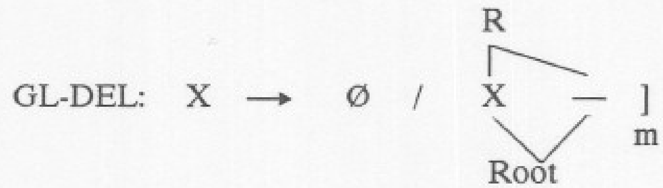
47. A similar situation prevails in Klamath where, according to ter Mors (1985), an empty nucleus and a following semivowel surface as the corresponding long vowel.

48. Like those affected by FLIP, the two slots affected by SPREAD actually always belong to the same rime, but the two rules need not mention syllable structure.

ye-Φʃa 'give 3ms' (/**y-wʃa**/) become like the one in **y-uʃa** 'steal 3ms' (/**y-uʃr**/).

FLIP and SPREAD are suspiciously similar, and SPREAD is needed anyway. In the absence of FLIP, SPREAD would predict ***iy-suw** instead of **i-su** for /**y-sw**/. Let us see what would happen if we discarded FLIP and adopted instead the following rule, which must apply after SPREAD.

(25)



GL-DEL deletes the final X slot in a rime whose nucleus and coda share the same melodic unit, on the condition that the X slot in question be morpheme-final. Here are the derivations for /**y-sw**/ 'drink aor 3ms', /**yma**/ (cf. (12I-c)) and /**zwy**/ 'winnow'.[49]

(26)

	/y-sw/	/yma/	/zwy/
CS	**(Øy)(sØw)**	**(Øy)(ma)**	**(Øz)(wØy)**
SPREAD	**iy uw**	**iy**	**iy**
GL-DEL	**Ø Ø**		**Ø**
	[isu]	*[iyma]	[zwi]

What went wrong in the derivation of /**yma**/ is that SPREAD applied, as it does in **i-su**. GL-DEL is not a viable alternative to FLIP.

The failure of SPREAD to operate in **yma** is akin to that of schwa epenthesis to operate before the initial consonant in **zwi**. In both cases an empty nucleus not preceded by an onset remains uninterpreted at the phonetic level. Why should empty nuclei behave differently when they are not preceded by an onset?

We shall make three assumptions. First, UG disallows onsetless syllables with an empty nucleus. Second, at the beginning of a syllabification domain—and only there—UG allows rimes which do not belong to a syllable. CS-C does indeed syllabify the initial segments in /**yma**/ and in /**zwy**/ as the codas of rimes with empty nuclei, but the rimes in question do not become part of syllables. Our third assumption is that the default schwa rule and SPREAD should be formulated so as to affect

49. Cf. e.g., **θ-zewy-eð** 'winnow 2s'.

only those empty nuclei which belong to a syllable.[50] These assumptions entail a complete overhaul of the syllabification procedure we proposed for ASR in section 2.

4. A NEW SYLLABIFICATION PROCEDURE

Of all the machinery proposed in section 2 we shall retain only (11), which is given again below for ease of reference as (30), and we shall adopt the following.

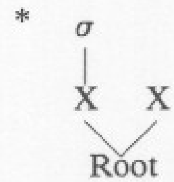
(27) Onset Convention: X R $\rightarrow$ σ

(28) R(V):

(29) Coda Rule: X_1 X_2 $\rightarrow$ R

(X_1 is either empty or dominated by N)

(30) GEMSYL:



CS-V and CS-C were both rules building a syllable with an onset and a rime. Onset formation has been factored out as (27): if a R(ime) is preceded by an X, both must belong to the same syllable. (28) replaces CS-V. It requires every occurrence of a nonempty N node to be dominated by a σ node. Hence a vowel will always end up dominated by a σ node, no matter what precedes it (we are assuming that all occurrences of /**a,i,u**/ are already associated with an N node before syllabification begins). (27) and (28) are both conventions which must apply whenever their conditions are met. (29) is the result of blending CODA (cf. (6c)) with the residue of CS-C. The conditions between parentheses restricts the nuclei of the rimes erected by rule (29) to empty slots and vowels: consonants cannot be syllabic in ASR. Here is for instance how /**!inafðn**/ is syllabified by (27)-(29).

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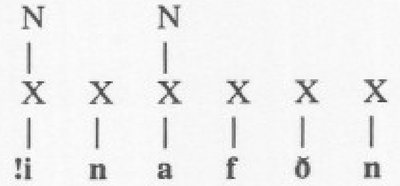
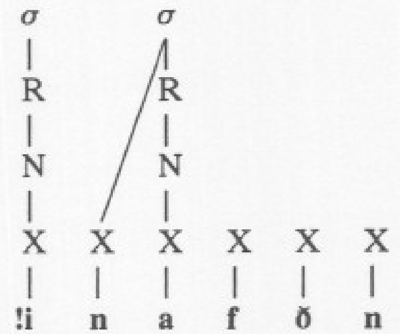
50. On the default schwa rule, cf. the text immediately under (20), p. 143.

(31) a. input rep

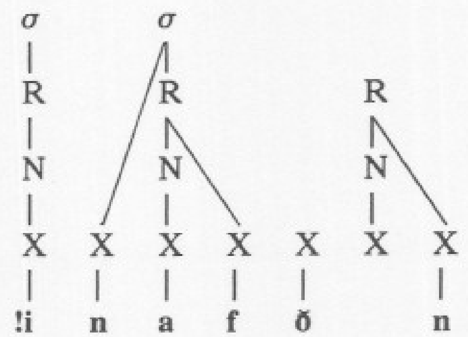


b. R(V)

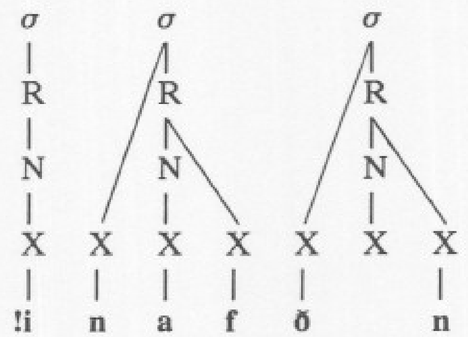
c. Onset Conv



d. Coda Rule



e. Onset Conv

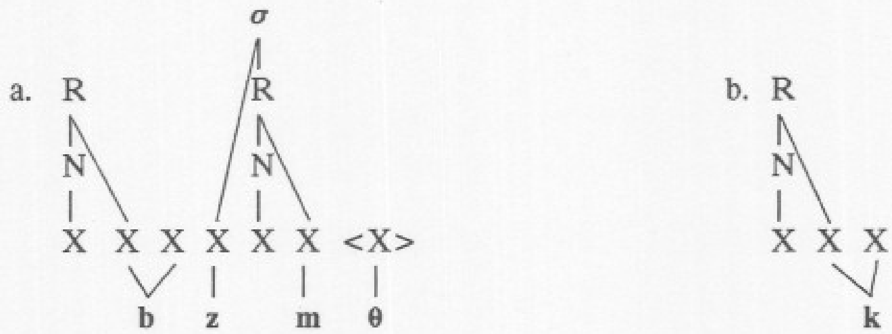


The structures built by (27)-(29) must all conform to that displayed in (16a), which we assume is given by UG. Hence the R nodes interpolated when R(V) operates, for instance (cf. (31b)).

The NOHIATUS condition (cf. (9)) has become superfluous, and so has (10). In a vowel sequence such as **/ua/** the Onset Convention requires **/u/** to become an onset, but including **u** into the following syllable would violate (16a), because σ would now dominate two N nodes.

Consider now **/bbz-m-<θ>/** 'push in, 3fp' (**bbzent**), and **/kk/** 'pass imper 2s' (**kk**), which (27)-(30) syllabify as **(Øbb)(zØm)θ** and **(Øk)k.**

(32)



These representations illustrate two features of our analysis. First, words with an initial **CC** sequence are syllabified with an initial rime which is not dominated by a σ node. Second, in a geminate it is not necessary that both slots belong to prosodic structure. Let us comment on the first point (on the second, cf. below).

According to (27)-(30) a σ node can be built only in two ways: by (28) over a nonempty N (i.e. over a V), or by (27) over a rime and a preceding X. Neither operation can apply to the initial rime in the words in (32) or in any others beginning with **CC**.[51] Since that rime does not belong to a syllable its empty nucleus will not be associated with the features characterizing schwa. In **kk** there is no other rime, and the word is phonetically vowelless.

The failure of a dangling **C** to trigger the erection of a syllable at the beginning of a word is reminiscent of the following asymmetry, which is

51. Cf. e.g. **zwi** in (26). An initial rime can acquire a σ node as a result of the operation of the rule FLIP (cf. (22)). For instance **i-mun** (cf. (13IV-b')) is at first syllabified as **(Øy)(mun)**. After the application of FLIP the nucleus of the initial rime is not empty anymore and the conditions of convention (28) are met.

briefly discussed in Rubach and Booij (1990:452). In Czech liquids are syllabic when they occur between two consonants (**srdce** 'heart') or word-finally after a consonant (**bratr** 'brother'), but not word-initially before a consonant (**rty** 'lips').

In assuming that a word may begin with a rime which does not belong to any σ we are adopting a proposal by McCarthy and Prince (1990:15) that "syllables at the periphery of a stem, word or other domain may be incomplete, consisting solely of a moraic consonant (a Coda) or a nonmoraic consonant (an Onset)". Adopting McCarthy and Prince's proposal for word-initial consonants allows us to give a unified account of the behavior of prefixal glides in ASR. Adopting it for word-final consonants such as the final **θ** in (32a), which we have considered until now as excluded from the purview of the syllabification mechanisms, would mean that **θ** must instead be syllabified as the onset of a rimeless syllable. We shall not pursue the matter here, as little depends on it in our discussion of ASR.

In (8) rule CS-C had to apply from right to left. Moving from one end of the string to the other was a way of enforcing exhaustivity, i.e. of insuring that no segment would be left out. Starting from the right end was a way of insuring that in a sequence of an odd number of consonants it would be the leftmost which would be left unpaired, as can be seen in (6b). We could again enforce exhaustivity by imposing right to left directionality on the application of (29). But Broselow (to appear) has weakened the appeal of right to left vs. left to right directionality as a parameter of syllable construction, and we have found it worthwhile to look for an alternative to right to left directionality in the case of ASR. We shall instead adopt the following two conditions. The first concerns the melodic units (i.e. the Root nodes) while the second concerns the X slots.

(33) *Melodic Exhaustivity*
Every melodic unit (i.e. every Root node) must be one of the following:
a. linked to a slot dominated by a syllable or a rime,
b. extraprosodic.

(34) *Slot Maximization*
As many X slots as possible must belong to a syllable or a rime.

To show how these conditions work, let us check that the syllabifications displayed in (31e) and in (32a) are the only ones compatible with them. Syllabifying /**!inafðn**/ as **(!i)(na)(fØð)n** is ruled out because **n** does not meet any one of the conditions in (33). Syllabifying that string as

(!i)(na)(fØð)(Øn), where **(Øn)** is a rime not part of any syllable, is ruled out because this violates the Onset Convention: in **(ð)(Øn)** the final rime and the preceding X do not constitute a syllable. Now to (32a). All melodic units are extraprosodic or linked to syllabic structure as required by (33). Not all X slots are, but (32a) meets Slot Maximization: syllabifying the second slot linked to /**b**/ cannot be done without leaving /**m**/ unsyllabified, in violation of (33).

Adopting conditions (33) and (34) renders right to left iteration superfluous.

(33) is a weakened version of Itô's principle of Prosodic Licensing. Whereas Itô's principle (Itô 1989:220) implies that all phonological units must be syllabified, (33) only requires it of melodic units. In (32), for instance, the first slot of the initial geminate is syllabified, but not the second.

To see why (34) is needed in addition to (33), consider the word /**a-!qbbið**/ 'bundle (flowers)' (**!aqebbið**). The parsings **!(a)(qØb)(bið)** and **!(aq)b(bið)** both meet Melodic Exhaustivity, and it is Slot Maximization which selects the former. A form such as /**ddz-n**/ 'crush 3mp' (**ddz-en**), on the other hand, shows that adopting (34) does not render (33) superfluous. Maximizing the number of syllabified slots yields **(Ød)(dØz)n** as well as the correct **(Ød)d(zØn)**, and it is Melodic Exhaustivity which excludes the former.

Condition (33) implies that the special status of geminates in the phonotactics of ASR (cf. (4)) is not a quirk of that language. It reflects an option provided by UG. There could exist a language with the following properties: all words must end in a vowel (***balik**) and consonant clusters are prohibited (***punta**), except that geminate consonants are allowed at the beginning of words (**dduma**) and between vowels (**dumma**). Such a language would be characterized as allowing only **(C)V** syllables (i.e., it would have no Coda Rule). (27) and (28) would syllabify **zzerro** as **z(ze)r(ro)**, where the unsyllabified first halves of **zz** and **rr** are licensed by (33a). Whether such a language exists has yet to be ascertained.

Unlike Turkish, which degeminates consonants so as to leave no slot unsyllabified (cf. Clements and Keyser 1983:59ff), ASR does not delete unsyllabified slots.

5. ON THE PHONETIC CORRELATES OF EMPTY NUCLEI

Schwa is in certain cases realized as a short unrounded central vowel with an aperture ranging from mid (e.g., in **ʒbeð** 'pull') to high (e.g., in **ddez** 'crush'). There are other cases, however, where it has only minimal phonetic manifestations, and in some contexts one may wonder whether it has any at all.[52] To an ear unattuned to ASR (i.e. FDs) schwa is often very difficult or impossible to identify. In some contexts it sounds like a mere consonant release, but this is not of much help, since in ASR stops are as a rule pronounced with a clearly articulated release.

As far as schwa is concerned, our transcriptions rely on OT's judgments. We have noted an occurrence of schwa wherever OT hears one, and only there. OT's judgements are clear-cut and almost always consistent over time.

Many readers will find this method of transcription rather disquieting: transcribing phonetically the vowels and consonants of a language does not in principle require any competence as a speaker. In what follows we shall clarify the empirical content of our transcriptions. Once again: we have written an **e** in our transcriptions wherever OT hears a vowel different from **a**, **i**, **u**, not wherever our rules predict one should occur. The occurrences of **e** in our transcriptions are data to be accounted for, not predictions made by our analysis. In some forms the vowels of our transcription and the voiced vocoids perceptible to FD's ear are not in a one-to-one relation, and the discussion in this section is a first attempt to clarify this relation. The upshot will be that although our transcriptions may not correspond to the final output of the phonological component, they faithfully mirror the distribution of vowels at a very late stage of the derivations.

One might expect to hear a voiced vocoid between two consonants wherever our transcription contains a vowel, and only there. Let us summarize here the reasons why in some cases this expectation is not met. Let us define a vocoid as a stretch of time, however short, where there is no articulation which is consonantal in the sense of Chomsky and Halle (1968: 302). Note that this definition does not say anything about voicing. In **CC** sequences in ASR the oral constriction of the first **C** is as a rule released before the oral constriction of the second **C** sets in.[53] By definition, then, the two consonants are separated by a short vocoid. The glottal characteristics of that vocoid depend on those of the

52. ASR is in this respect similar to the Irjen dialect (Kabylie) where, according to Basset and Picard (1948:9), schwa is "un élément vocalique [...] allant, suivant la rapidité du débit en particulier, de la voyelle bien marquée jusqu'à l'évanouissement total [...]. Toutes les voyelles sont sonores; il se pourrait cependant que ə puisse s'assourdir, ne laissant [...] pour tout résidu, qu'une suspension." According to Penchoen (1973:94) schwa is in some cases voiceless between voiceless consonants in the Ayt Ndhir dialect.

53. I.e. ASR as a rule uses open transition (Bloomfield 1933:119). Bloomfield's discussion may give the impression that open transition is mandatory in the French examples he cites. Close transition is possible as well, and it is the preferred option in some of his examples in present day Parisian French.

surrounding consonants. Add to this the fact that **e**, which can be extremely short, may (in some cases must) be realized voiceless.

Let us first examine those cases where no vocal cord vibration can be heard between two consonants which are separated by **e** in our transcription. Many of these can be ascribed to a pervasive process which devoices schwa between two voiceless consonants. There are many contexts where this devoicing seems to be mandatory in normal speech. It is blocked, however, in those prepausal syllables which intonation requires to carry a high tone. In **θarefteʃt** 'turnip', for instance, vocal cord vibration may be absent between the beginning of **f** and the release of the final **t**, unless the word is pronounced under an intonation which requires a final high pitch, e.g., in an incredulous question. Before a pause, then, when the two consonants are voiceless, the difference between **...CeC** and **...CC** in our transcriptions reflects that between those sequences where a short voiced vocoid occurs under a final high pitch and those where such a vocoid is not allowed no matter what.[54] Here is an example of such a contrast: **sθexθux-eθ** 'let boil imper impf 2p' (from **/sθxθux-θ/**) vs. **ttu-x θ** (from **/ttu-ʁ <θ>/**) 'forget-1s do3ms'.

To FD's ear there is often no difference between a devoiced schwa and the release of the first consonant in a sequence of two voiceless consonants. One context where a mere release of the constriction is a sufficient phonetic cue for the occurrence of schwa is between identical consonants. There is for instance a clear phonetic difference between the end of **ye-sḥuss** 'feel slightly sick 3ms' and that of **ye-rruyses** 'shiver 3ms', even in those utterances where the final schwa is voiceless. **ye-sḥuss** ends in a long, steady-state s (contrasting with the short one in **ðrus** 'a little'), whereas what one hears at the end of **ye-rruyses** is a long **s** sound in the middle of which there is a marked weakening of the friction, and which gives the impression of two **s** sounds separated by a suspension, in Basset and Picard's apt terms (cf. note 52). This "suspension" is similar to the "homorganic open transition" which may be heard when **a** is pronounced voiceless in **this assortment** (cf. Catford 1977:220). Since representation (35a) below is already preempted by the long steady-state **s** at the end of **ye-sḥuss**, we suppose that the temporarily suspended **s** in **ye-rruyses** corresponds to the underlying representation (35b), which syllabification changes into the surface representation (35c):[55]

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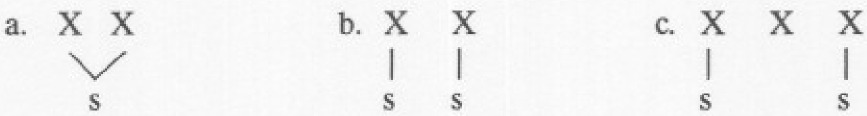
54. In Moroccan Colloquial Arabic, according to Heath (1987:184), schwa deletion in word-final syllables is blocked by "list intonation", and in Japanese high vowel devoicing is blocked "when a final syllable in the devoicing environment must carry a rising intonation" (Vance 1987:51).
55. When the underlying sequence (35)b is not broken up by syllabification, "coronal fusion" (on which cf. below) changes it into (35)a, as in **rruyess-en** 'shiver 3mp'.

(35)



The schwa in **i-sess** 'drink impf 3ms' may also be voiceless unless under a high tone, and the voiceless sequence **sess** at the end of this form is phonetically distinct from **s**, **ss** and **ses** in the forms above. The phonetic contrast between **sess** (without vocal cord vibration), **ss** and **s** also occurs in non-prepausal syllables, cf., e.g., **i-sess iθ** 'drink:impf-3ms do3ms', **missa** 'table', **i-sameḥ** 'forgive 3ms'. The fact that some realizations of (35)c and of similar sequences are devoid of any glottal vibrations is our first piece of evidence in favor of the existence of devoiced schwas in ASR.

Compare now **ye-xsi** 'go out (light) 3ms' and **i-xesy-en** 'id. part', from **/y-xsy/** and **/y-xsy-n/**. FD cannot hear any difference between the sequence transcribed **xs** in the first form and that transcribed **xes** in the second, and one conceivable reason for this may be that there isn't any. Note however that the 3ms prefix **/y-/** is realized **ye-** in the first form and **i-** in the second. Rule FLIP (cf. (22)) accounts for this difference if at the stage of the derivations where FLIP is applicable **/x/** is an onset in **i-xesy-en** but not in **ye-xsi**. In other words one can make sense of the realizations of the prefix only if one assumes that there exists some level of representation where **x** and **s** are adjacent in **ye-xsi** but not in **i-xesy-en**. In **i-xesy-en** what occurs between **x** and **s** is, according to our analysis, the same entity which occurs between **y** and **n**, viz. an empty nucleus, and it is not surprising that OT should hear both as "the same thing".

This example illustrates our line of argumentation in this section: our analysis predicts the occurrence of a vocalic nucleus in certain places and not in others, and one might expect this nucleus always to be realized as a voiced vocoid. But in some contexts late processes obliterate the difference between **CeC** and **CC**. However, there are various phonetic facts which are perceptible even to an ear unattuned to ASR and which can be explained only if one assumes that syllable nuclei occur precisely as indicated in our transcription (i.e. as perceived by OT).

Let us now turn to those cases where one hears a voiced vocoid between two consonants which are not separated by a vowel in our transcription. This happens only in certain contexts where one of the two consonants, often the second, is voiced. Consider for instance **!ye-qðu** 'snap 3ms' (from **/y-!qðw/**) and **!i-qeðw it** 'snap-3ms do3fs' (from **/y-!qðw**

it/). To FD's ear the short voiced vocoid which separates the release of **q** from the onset of **ð** does not sound any different in **!ye-qðu** and in **!i-qeðw it**, although only the vocoid in the latter form corresponds to a schwa. But here again the realizations of the prefix **/y-/** suggest that in the representations which were inputs to rule FLIP **q** was an onset in **!i-qeðw it** but not in **!ye-qðu**.

The extra-short voiced vocoids which occur in ASR are of two kinds, then. Some are realizations of a syllabic nucleus while others are mere transitions between two consonants. The two types of vocoids are undistinguishable to FD's ear, but not to the native speaker's ear, witness the fact that OT perceives those of the first kind but not the others. We have not found any phonological process which would be sensitive to the voiced vocoids of the second kind, i.e. these vocoids "do not count" for the phonology of ASR.[56]

Our distinction between those vocoids (voiced or voiceless) which count as nuclei and those which do not is analogous with the distinction between "major transitions" and "minor transitions" made by Harrell (1962) in his insightful discussion of similar facts in Moroccan Arabic. It is also reminiscent of the fact that in Imdlawn Tashlhiyt, a Berber dialect where any consonant may be a syllabic peak, there does not exist a one-to-one correspondence between syllabic consonants and short transitional vocoids (cf. Dell and Elmedlaoui 1985:115–118).

In a sequence of two voiceless consonants followed by a voiced one the two phenomena presented above combine in certain cases to give rise to an apparent metathesis. Consider for instance the plural form of **!asfeð** (**/a-!sfð/**) 'charred wood', which is **!isefðawen** (from **/i-!sfð-aw-n/**). To FD's ear this form actually sounds as [**!isfəðawən**]. Schwa is voiceless between voiceless **s** and **f**, and the glottal vibrations of **ð** begin before its oral constriction, hence the voiced vocoid one can hear between **f** and **ð**. It is remarkable, however, that **!isefðawen** and similar nouns behave phonologically as implied by their transcription, i.e., as though the consonant following their initial vowel were an onset. This is illustrated in the table below. In the forms of lines a-b and a′-b′ there is a one-to-one correspondence between the occurrences of **e** and the voiced

56. As already noted in Dell and Elmedlaoui (1988:2) Parisian French also has schwa-like voiced vocoids which "do not count" for any phonological rule. These occur at the release of a prepausal stop, even a voiceless one, for instance at the end of **bac**, **cap**, etc. Speakers of French have to learn to suppress them when they speak English. These vocoids are not the same thing as the prepausal schwas heard in southern France.

vocoids. The forms of lines c-c′, on the other hand, show the apparent metathesis under discussion.[57]

(36)

		I /V-√/	II /G-√/	III /n G-√/
a.	/!sfð/	**!a-sfeð**	**!we-sfeð**	**ŋŋ$^{\circ}$e-sfeð**
b.	/!ðaʁal/	**!a-ðaʁar**	**!u-ðaʁar**	**!u-ðaʁar**
c.	/!sḥrawy/	**!a-seḥrawi**	**!u-seḥrawi**	**!u-seḥrawi**
a′.	/smʁ/	**i-smeʁ**	**ye-smeʁ**	**ŋŋ^{y}e-smeʁ**
b′.	/smʁ-an/	**i-semʁ-an**	**i-semʁ-an**	**i-semʁ-an**
c′.	/!sfð-aw-n/	**!i-sefð-awen**	**!i-sefð-awen**	**!i-sefð-awen**

Column I gives a noun in its free state form,[58] column II gives its bound state form and column III gives the prepositional phrase comprised of the preposition /n/ 'of' followed by that bound state form. The forms of I, II and III in (36a), for instance, are derived from intermediate representations which are /**a-!sfð**/, /**w-!sfð**/ and /**n w-!sfð**/, and similarly those in (36a′) derive from /**i-smʁ**/, /**y-smʁ**/ and /**n y-smʁ**/. The phonological forms in column I begin with a vowel, /**a**/ or /**i**/, which is deleted in the bound state.[59] In column II the bound state prefix is an underlying glide, /**w-**/ in lines a-c, and /**y-**/ in lines a′-c′. The realizations of that prefix are as predicted by rule FLIP. The forms a-b and a′-b′ of column III summarize the special behavior of the preposition /**n**/ in ASR: it is deleted when the bound state prefix is realized as a vowel (b-b′) or else (a-a′) it blends with that prefix to yield a geminate velar nasal. The forms of lines c-c′ behave in all respects like those of lines b-b′, i.e., they show that the initial consonant of the radical is an onset.

On the basis of the data presented in section 3.1. the readers can see for themselves that like the behavior of the initial glides with respect to FLIP, the distribution of the sequences **CGeC** and **CeGC** (G a glide) and the devoicing of **y** and **w** to **ç** and **Φ** can only be accounted for in a simple fashion on the basis of the distribution of syllabic nuclei as recorded in our transcriptions. Another such phenomenon is coronal fusion, to which we now turn to conclude this section.

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57. In line c, what OT hears as **!seḥrawi** actually sounds like [**!sḥarawi**]. The short intrusive vocoid before **r** borrows its voicedness from **r** and its supralaryngeal posture from **ḥ**.

58. The nouns in table (36) have the following meanings: (a) 'charred wood'; (b) 'blind man'; (c) 'Sahrawi'; (a′) 'slave'; (b′) 'slave p'; (c′) 'charred wood p'.

59. On the phonology of the bound state and of the preposition /**n**/ in ASR, cf. APPB, ch. 4.

In ASR the geminate reflex of a nonstrident coronal fricative is a stop; geminate **θ** is realized as **tt** and geminate **ð**, as **tt** or **dd**.[60] This strengthening occurs for instance in the /CCC/ verbs, which form their imperfective stems by geminating their medial consonant: **zðer** 'dwell' (/**zðl**/), impf **zedder**, **fθḥ** 'swim' (/**fθḥ**/), impf **fetteḥ**. The rule which turns certain geminates, the nonstrident coronals among them, into stops, must look something like the following (F stands for a set of feature specifications):

(37) STR: [F] → [-cont] / X X (both X linked to a single position: __)

Strengthening also systematically operates in heteromorphemic sequences of nonstrident coronals. Here are a few examples.

(38)	a.	**/θ-ðhhn/**	**ddehhen**	'coat impf 3fs'
	b.	**/θ-mamð-ð ayi/**	**θmameddayi**	'smear-2s do1s'
	c.	**/!suð-θ ayi/**	**!suttayi**	'blow:imper-2p dat1s'
	d.	**/θ-!ðaʁal-<θ>/**	**!ddaʁač**	'blind woman bs'
	e.	**/awy-θ <θ>/**	**awyett**	'remove:imper-2p do3ms'
	f.	**/θ-a-!qbbið-<θ>/**	**!θaqebbitt**	'bundle (flowers) dim"

As illustrated by forms (38a,c,d,f), strengthening also affects adjacent consonants which are not identical in the phonological representation but which assume this form through regressive voicing assimilation. In (38a) and (38b) the sequences /**θ-ð**/ and /**ð-ð**/ must be fused into a geminate **ð** before rule STR can turn that geminate into a stop. Let us simply lump together the operations which effect this fusion and call them "coronal fusion".[61] Coronal fusion does not affect the CC sequences which are broken up as a result of syllabification, i.e. coronal fusion must apply after syllabification. This is illustrated by the examples below, where the coronal sequences are the same as in (38a-d).

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60. **tt** in radicals which contain an emphatic segment, and **dd** elsewhere. Other consonants besides **θ** and **ð** strengthen under gemination cf. APPB.

61. In ASR a sequence of two identical consonants which are adjacent inside a phonological phrase at the phonetic level is always homophonous with the corresponding geminate. For instance, the heteromorphemic /**n-n**/ sequence at the beginning of **n-nudem** 'doze 1p' (from /**n-nudm**/) is homophonous with the lexical geminate in **nnum-en** 'get used to 3mp' (from /**nnum-n**/). Chtatou (1982:188) posits a convention which collapses two adjacent consonants into a geminate.

(39)	a.	**/θ-ðhn/**	**θeðhen**	'coat 3fs'
	b.	**/θ-mamð-ð/**	**θmamðeð**	'smear-2s'
	c.	**/!suð-θ/**	**!suðeθ**	'blow imper 2p'
	d.	**/θ-ðbir-<θ>/**	**θeðbeaθ**	'pigeon f bs'

The relevance of coronal fusion to our discussion of the phonetic realizations of empty nuclei is the following. Which underlying **CC** sequences are subject to coronal fusion is a function of syllabification, and has nothing to do with the phonetic realization of empty nuclei. On the one hand an intervening empty nucleus blocks coronal fusion no matter what its phonetic realization may be. On the other hand the absence of any intervening segment allows coronal fusion, even in contexts where one otherwise observes transitional vocoids with no phonological value. One example will suffice to illustrate the latter statement. As we saw earlier FD often clearly perceives a transitional voiced vocoid between a voiceless consonant and a voiced one which immediately follows it. This happens even when the two consonants are otherwise identical. One can for instance hear such a vocoid between **s** and **z** in **s-zewʁ-en** (/**s-zwʁ-n**/) 'cause to redden 3mp'. However the possibility that such a vocoid may also show up between **θ** and **ð** in (38a) and (38d) is irrelevant at the stage of the derivations when coronal fusion is applicable: coronal fusion operates after syllabification, but before whatever mechanisms are responsible for the existence of transitional vocoids.

Before leaving coronal fusion, let us note that some of the sequences subject to it are tautomorphemic (cf. e.g., (40IIb)). The lexical representations of ASR must be such as to distinguish between a geminate (i.e., a single bundle of features linked to two successive slots) and two identical feature bundles each linked to its own slot. We note the latter sequences as /**C ^ C**/ in order to distinguish them from the geminates.[62] Here are two instances of the contrast in question.[63]

(40)		I	II	
a.	**/sm ^ m/**	**ye-smem**	**semm-en**	'rise (dough)'
a′.	**/!zmm/**	**!i-zemm**	**!zemm-en**	'wring'
b.	**/zð ^ ð/**	**ye-zðeð**	**zedd-en**	'grow thinner'
b′.	**/bedd/**	**i-bedd**	**bedd-en**	'get up'

62. We borrow this notation from Heath (1987:21).
63. (I) /**y-√**/ 3ms; (II) /**√-n**/ 3mp. Other examples can be found in APPB: 110–11. An earlier example of a /**C ^ C**/ sequence is the verb /**ruys ^ s**/ discussed in the text above (35).

ASR is one of those languages which violate the Obligatory Contour Principle from the most abstract level of representation onwards.[64] ASR also has lexical items where the adjacent units violating the Obligatory Contour Principle differ in quantity. **aqnenni** 'rabbit' (**/a-qn^nny/**) contains a plain consonant followed by a geminate, whereas the geminate comes first in **ʒeffef** 'mop (floor)' (**/ʒff^f/**).

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64. On the Obligatory Contour Principle, cf. McCarthy (1986), Odden (1988), and references therein.

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CNRS, Paris (Dell)
Université de Paris VIII (Tangi)